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Remarks and Instructions

What's Changed in the Design Manual for July 2010?

For a summary of the changes, see page 3. Note that some of the chapters have a new style/format.

General

- Download the current electronic WSDOT *Design Manual*, the latest revision package, or separate chapters at: http://www.wsdot.wa.gov/publications/manuals/m22-01.htm
- Engineering Publications no longer sells printed department manuals or publications to the general public, contractors, consultants, cities, or counties (WSDOT employees, see note below). This service is now available through the Washington State Department of Printing's Fulfillment Center. Printed copies of WSDOT's most requested manuals are available through its online service called the General Store. **This is a secure website**. Once you have established an account, you may purchase any product available: https://fortress.wa.gov/prt/printwa/wsprt/default.asp
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1360 Interchanges	1360-9&10	1360-9&10
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1430 Transit Facilities	1430-7&8	1430-7&8
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1610 Traffic Barriers	1610-13&14	1610-13&14
	1610-27&28	1610-27&28
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Revision Marks

- A new date appears on the footer of each page that has changes.
- Revision marks (underlines/sidebars) are used as a convenience to show designers what has changed.
- When a chapter is new or completely rewritten (such as Chapter 1350), no revision marks are applied.

Summary of Design Manual Changes – July 2010

(Revisions merit careful study beyond this summary)

MAJOR CHANGES & INCORPORATED ERATTA

Chapter 300 – Design Documentation, Approval, and Process Review

- Revised to clarify the documentation requirements for Project Change Request forms.
- Includes ITS items and other traffic electrical items, which coincide with revisions to Chapter 1050, Intelligent Transportation Systems.

Chapter 720 – Bridges

- Revised policy for bridge median openings.
- Added a reference to the new Chapter 1515, Shared-Use Paths.

Chapter 730 – Retaining Walls and Steep Reinforced Slopes

- Incorporated errata: Minor change to Exhibit 730-13b (corrected word in flowchart).

Chapter 1040 – Illumination

- Incorporated errata: Corrected text reference to see Exhibit 1040-11.
- Incorporated errata: Corrected 2^{nd} equation in Exhibit 1040-23 so the factor S is squared.

Chapter 1050 – Intelligent Transportation Systems

- Revised to reflect the dynamic nature of ITS and to provide:
  - Clear guidance that systems engineering is required for all ITS projects, regardless of funding source or program.
  - Clear guidance on how to determine and document the appropriate level of systems engineering based on the complexity, risk, and scope of ITS projects.
  - Definitions of categories of ITS projects.
  - Guidance on how to classify ITS projects.
  - Guidance on applying systems engineering, including the "V" diagram.

Chapter 1100 – Design Matrix Procedures

- Added "ITS" to each of the five Design Matrix exhibits, to coincide with revised Chapter 1050.
- Added reference to Chapter 1050, Intelligent Transportation Systems, and Chapter 1515, Shared-Use Paths (page 1100-7).

Chapter 1120 – Basic Design Level

- Revised to bring ITS to the attention of designers as a result of the revisions to Chapter 1050.

Chapter 1140 – Full Design Level

- Added new section 1140.18, Traffic Signal Control, Illumination, and Intelligent Transportation Systems (ITS), to coincide with revised Chapter 1050.
- Added references to the new Chapter 1515, Shared-Use Paths.

Chapter 1230 – Geometric Cross Section

- Revised median in the Exhibit 1230-4a two-way ramp drawing to include shoulders.
- Revised Exhibit 1230-4b, Note [3], to refer two-way ramp median width to Chapter 1360.

Chapter 1310 – Intersections at Grade

- Added design guidance related to countermeasures for wrong-way movements.
- Made minor revisions to lane alignment, interchange ramp terminals, and design vehicle selection.
- Moved all exhibits close to the text that refers to them.
- Note: Revisions to Chapters 1230 (above) and 1360 (below) are related to Chapter 1310 revisions.

Chapter 1330 – Traffic Control Signals

- Changed "Project File" to "DDP" on page 1330-38 to keep the chapter consistent with the revisions in Chapter 1350.

Chapter 1350 – Railroad Grade Crossings

- Rewritten to make the chapter more concise and readable and to conform to federal policy and WSDOT signal policy.

Chapter 1360 – Interchanges

- New section 1360.05(5) was added regarding two-way ramps, to coincide with changes to Chapter 1310.

Chapter 1510 – Pedestrian Design Considerations

- Added guidance on Maximum Extent Feasible document.
- Revised Exhibit 1510-27 with minor clarifications.
- Added statement that reads: The curb ramp maximum running slope shall not require the ramp length to exceed 15 feet.
- Deleted two of the three illustrations in Exhibit 1510-7.
- Made other minor text changes.
- Note: No revision marks were used since there were as many deletions as insertions.

Chapter 1515 – Shared-Use Paths

- This is a new chapter, whose purpose is to emphasize that pedestrians are users of shared-use paths and that accessibility requirements apply in their design.
- This new chapter takes material from Chapter 1520.
- The section on landings, running slopes, and rest areas is new guidance and was the impetus in creating this new chapter. This section instructs to provide shared-use path landings when certain conditions are present: slopes greater than 5% and less than 8.3% require a landing for every 10 feet of elevation change.
- Further work is planned for this chapter in the next revision cycle.

Chapter 1520 – Roadway Bicycle Facilities

- Republished without the shared-use path guidance, which was moved to Chapter 1515.
- Reorganized the narrative and revised the exhibits.
- Added "Roadway" to chapter title.

Chapter 1600 – Roadside Safety

- Removed first sentence in 1607(1)(b)2 related to rumble strips on undivided highways.
- Added a reference to the new Chapter 1515, Shared-Use Paths.

Chapter 1610 – Traffic Barriers

- Deleted an unavailable post type, corrected the names of several guardrail terminals, and added two references.

MINOR CHANGES

Chapter 100 – Manual Description

- Added a description of the new Chapter 1515, Shared-Use Paths.

Chapter 1260 – Sight Distance

- Added a reference to the new Chapter 1515, Shared-Use Paths.

Chapter 1320 – Roundabouts

- Corrected a reference from Chapter 550 to Chapter 540.

Chapter 1420 – HOV Direct Access

- Added a reference to the new Chapter 1515, Shared-Use Paths.

Chapter 1430 – Transit Facilities

- Added a reference to the new Chapter 1515, Shared-Use Paths.

Washington State
Department of Transportation

TECHNICAL MANUAL

Design Manual

Volume 1 – Procedures

M 22-01.07

July 2010

Division 1 – General Information
Division 2 – Hearings, Environmental, and Permits
Division 3 – Project Documentation
Division 4 – Surveying
Division 5 – Right of Way and Access Control
Division 6 – Soils and Paving
Division 7 – Structures
Division 8 – Hydraulics
Division 9 – Roadside Development
Division 10 – Traffic Safety Elements

Environmental and Engineering Programs
Design Office

Americans with Disabilities Act (ADA) Information

Materials can be provided in alternative formats by calling the ADA Compliance Manager at 360-705-7097. Persons who are deaf or hard of hearing may contact that number via the Washington Relay Service at 7-1-1.

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Division 1 – General Information

Division 2 – Hearings, Environmental, and Permits

Division 4 – Surveying

Division 5 – Right of Way and Access Control

Division 9 – Roadside Development

Division 10 – Traffic Safety Elements

Division 11 – Project Design Criteria

Division 12 – Geometrics

Division 14 – HOV and Transit

Division 15 – Pedestrian and Bicycle Facilities

Division 16 – Roadside Safety Elements

Division 17 – Roadside Facilities

Division 12 – Geometrics: Covers geometric plan elements; horizontal alignment; lane configurations and pavement transitions; geometric profile elements; vertical alignment; geometric cross sections; and sight distance.

- **Chapter 1210 – Geometric Plan Elements:** The design of horizontal alignment, lane configuration, and pavement transitions.
- **Chapter 1220 – Geometric Profile Elements:** The design of vertical alignment.
- **Chapter 1230 – Geometric Cross Section:** Roadway width and roadside slope design.
- **Chapter 1240 – Turning Roadways:** Widening curves to make the operating conditions comparable to those on tangent sections.
- **Chapter 1250 – Superelevation:** Superelevating curves and ramps so design speeds can be maintained.
- **Chapter 1260 – Sight Distance:** Stopping, passing, and decision sight distance design elements.
- **Chapter 1270 – Auxiliary Lanes:** Auxiliary facilities such as climbing lanes, passing lanes, slow-vehicle turnouts, shoulder driving for slow vehicles, emergency escape ramps, and chain-up areas.

Division 13 – Intersections and Interchanges: Addresses the design considerations of at-grade intersections, roundabouts, road approaches, railroad grade crossings, and traffic interchanges.

- **Chapter 1310 – Intersections at Grade:** Designing intersections at grade, including at-grade ramp terminals.
- **Chapter 1320 – Roundabouts:** Guidance on the design of roundabouts.
- **Chapter 1330 – Traffic Control Signals:** The use of power-operated traffic control devices that warn or direct traffic.
- **Chapter 1340 – Road Approaches:** The application and design of road approaches on state highways.
- **Chapter 1350 – Railroad Grade Crossings:** The requirements for highways that cross railroads.
- **Chapter 1360 – Traffic Interchanges:** The design of interchanges on interstate highways, freeways, and other multilane divided routes.
- **Chapter 1370 – Median Crossovers:** Guidance on locating and designing median crossovers for use by maintenance, traffic service, emergency, and law enforcement vehicles.

Division 14 – HOV and Transit: Provides design guidance on HOV lanes and transit facilities.

- **Chapter 1410 – High-Occupancy Vehicle Facilities:** Evaluating and designing high-occupancy vehicle (HOV) facilities.
- **Chapter 1420 – HOV Direct Access:** Design guidance on left-side direct access to HOV lanes and transit facilities.
- **Chapter 1430 – Transit Benefit Facilities:** Operational guidance and information for designing transit facilities such as park & ride lots, transfer/transit centers, and bus stops and pullouts.

Division 15 – Pedestrian and Bicycle Facilities: Provides guidance on pedestrian and bicycle facility design.

- **Chapter 1510 – Pedestrian Facilities:** Designing facilities that encourage efficient pedestrian access that meets ADA.
- **Chapter 1515 – Shared-Use Paths:** Guidance that emphasizes pedestrians are users of shared-use paths and accessibility requirements apply in their design.
- **Chapter 1520 – Roadway Bicycle Facilities:** Selecting and designing useful and cost-effective bicycle facilities.

Division 16 – Roadside Safety Elements: Addresses design considerations for the area outside the roadway, and includes clear zone, roadside hazards, safety mitigation, traffic barriers, and impact attenuator systems.

- **Chapter 1600 – Roadside Safety:** Clear zone design, roadside hazards to consider for mitigation, and some roadside safety features.
- **Chapter 1610 – Traffic Barriers:** Design of traffic barriers based on the design levels identified in the design matrices.
- **Chapter 1620 – Impact Attenuator Systems:** Permanent and work zone impact attenuator systems.

Division 17 – Roadside Facilities: Provides design guidance for the area outside the roadway, including rest areas and truck weigh sites.

- **Chapter 1710 – Safety Rest Areas and Traveler Services:** Typical layouts for safety rest areas.
- **Chapter 1720 – Weigh Sites:** Guidance on designing permanent, portable, and shoulder-sited weigh sites.

be variances. A project or corridor analysis may also constitute a design variance if that analysis leads to a decision to use a design level or design classification that differs from what the *Design Manual* specifies for the project type.

Design Variance Inventory (DVI) A list of design elements that will not be improved in accordance with the *Design Manual* criteria designated for the project.

Design Variance Inventory System (DVIS) A database application developed to generate the DVI form. The DVIS also provides query functions, giving designers an opportunity to search for previously granted variances. The DVIS was started in the early 2000s and does not identify prior variances. The *Design Manual* is constantly being refined and guidelines change over time. What may have been a design variance previously may not be a deviation today. The DVIS database is intended for internal WSDOT use only, and WSDOT staff access it from the left margin of this website: http://wwwi.wsdot.wa.gov/Design/

deviation A documented decision granting approval at project-specific locations to differ from the design level specified in the *Design Manual* (see Chapter 1100 and Exhibit 300-1).

environmental acronyms – (see Chapter 220 for definitions)

- ***NEPA*** National Environmental Policy Act
- ***SEPA*** [Washington] State Environmental Policy Act
- ***CE*** NEPA: Categorical Exemption
- ***DCE*** Documented Categorical Exclusion
- ***CE*** SEPA: Categorical Exception
- ***EA*** Environmental Assessment
- ***ECS*** Environmental Classification Summary
- ***EIS*** Environmental Impact Statement
- ***ERS*** Environmental Review Summary
- ***FONSI*** Finding Of No Significant Impact
- ***ROD*** Record of Decision

evaluate upgrade (EU) A decision-making process to determine whether or not to upgrade an existing design element as designated in the design matrices. Documentation is required (see Exhibit 300-1).

FHWA Federal Highway Administration.

HQ Washington State Department of Transportation Headquarters organization.

Project Analysis Documentation that justifies a change in design level and/or decisions to include, exclude, or modify design elements specific to a project only (also see Chapter 1100).

Project Change Request Form A form used to document and approve revisions to project scope, schedule, or budget from a previously approved Project Definition (see ***Project Summary***). Include copies in the Design Documentation Package.

Project Development Approval Final approval of all project development documents by the designated representative of the approving organization prior to the advertisement of a capital transportation project (see Exhibit 300-2).

Project File (PF) A file containing all documentation and data for all activities related to a project (see 300.01 and 300.04).

- ***Design Documentation Package (DDP)*** The portion of the Project File, including Design Approval and Project Development Approval, that will be retained long term in accordance with WSDOT document retention policies. Depending on the scope of the project, it contains the Project Summary and some or all of the other documents discussed in this chapter. Common components are listed in Exhibit 300-5. Technical reports and calculations are part of the Project File, but are not designated as components of the DDP. Include estimates and justifications for decisions made in the DDP (see 300.04(2)). The DDP explains how and why the design was chosen, and documents approvals (see 300.01).

Project Summary A set of electronic documents consisting of the Design Decisions (DD), the Environmental Review Summary (ERS), and the Project Definition (PD). The Project Summary is part of the design documentation required to obtain Design Approval and is ultimately part of the design documentation required for Project Development Approval (see 300.06).

- ***Design Decisions (DD)*** An electronic document that records major design decisions regarding roadway geometrics, roadway and roadside features, and other issues that influence the project scope and budget.
- ***Environmental Review Summary (ERS)*** An electronic document that records the environmental requirements and considerations for a specific project.
- ***Project Definition (PD)*** An electronic document that records the purpose and need of the project, along with program level and design constraints.

scoping phase The first phase of project development for a specific project, the scoping phase follows identification of the need for a project and precedes detailed project design. It is the process of identifying the work to be done and developing a cost estimate for completing the design and construction. The Project Summary, engineering and construction estimates, and possibly several technical reports (geotechnical, surfacing, bridge condition, and so on) are developed during this phase.

300.04 Design Documentation

(1) Purpose

Design documentation records the evaluations and decisions by the various disciplines that result in design recommendations. Design assumptions and decisions made prior to and during the scoping phase are included. Changes that occur throughout project development are documented. Required justifications and approvals are also included.

The "Design Documentation Checklist" has been developed as a tool (optional) to assist in generating the contents of the DDP and the PF:
www.wsdot.wa.gov/design/projectdev/

(2) Design Documents

The DDP portion of the PF preserves the decision documents generated during the design process. In each package, a summary (list) of the documents is recommended.

The design documents commonly included in the PF and DDP for all but the simplest projects are listed in Exhibit 300-5.

Documentation is not required for components not related to the project as dictated by the design matrices.

The DVI is needed for all projects that have design variances. The DVI lists all EUs not upgraded to the applicable design level, DEs, and deviations as indicated by the design matrices. Record variances resulting from a project or corridor analysis in the DVI. Use the DVIS database to record and manage:

- Individual design variances identified during project development.
- Variances resulting from a project or corridor analysis.

The DVIS database is found at the left margin of this website:
http://wwwi.wsdot.wa.gov/Design/

The ERS and the PD are required for most projects. Exceptions will be identified by the HQ Project Control and Reporting Office.

The DD is not required for the following project types unless they involve reconstructing the lanes, shoulders, or fill slopes. Since these and some other project types are not included in the design matrices, evaluate them with respect to modified design level (M) for non-NHS routes and full design level (F) for NHS routes. Include in the evaluation only those design elements specifically impacted by the project. Although the following list illustrates some of the project types that do not require a DD, the list is not intended to be a complete accounting of all such projects. Consult with the appropriate ASDE for projects not included on the list.

- Bridge painting
- Crushing and stockpiling
- Pit site reclamation
- Lane marker replacement
- Guidepost replacement
- Signal rephasing
- Signal upgrade
- Seismic retrofit
- Bridge joint repair
- Navigation light replacement
- Signing upgrade
- Illumination upgrade
- Intelligent Transportation System (ITS) upgrade
- Rumble strips
- Electrical upgrades
- Major drainage
- Bridge scour
- Fish passage
- Other projects approved by the HQ Design Office

(3) Certification of Documents by Licensed Professionals

All original technical documents must bear the certification of the responsible licensee (see Executive Order E 1010).

(4) Design Exception (DE), Evaluate Upgrade (EU), and Deviation Documentation

In special cases, projects may need to address design elements, which are shown as blank cells in a design matrix (see Exhibit 300-1). These special cases must be coordinated with the appropriate Assistant State Design Engineer (ASDE) and the HQ Project Control and Reporting Office. When this is necessary, document the reasons for inclusion of that work in your project.

Matrix Cell Contents	Design Element Meets Specified Design Level	Document to File[1]	Record in DVIS[2]
Blank cell in design matrix		No[3]	No
Cell Entry			
Full (F), Modified (M), or Basic (B) (with no DE or EU qualifiers)	Yes	No	No
	No[4]	Yes[5]	Yes
Design Exception (DE)	Yes[3]	DDP	No
	No	DDP	Yes
Evaluate Upgrade (EU)[5]	Yes	DDP	No
	No	DDP	Yes

DDP = Design Documentation Package

Notes:

[1] See 300.04(3).

[2] See 300.04(2).

[3] Document to the DDP if the element is included in the project as identified in the Project Summary or Project Change Request Form.

[4] Nonconformance with specified design level (see Chapter 1100) requires an approved deviation.

[5] Requires supporting justification (see 300.04(4)).

Design Matrix Documentation Requirements

Exhibit 300-1

When the design matrices specify a DE for a design element, the DE documentation specifies the matrix and row, the design element, and the limits of the exception. Some DEs require justification. Include this in the DVIS. When a DVI is required for the project, the DE locations are recorded in the inventory.

The EU process determines whether an item of work will or will not be done, through analysis of factors such as benefit/cost, route continuity, accident reduction potential, environmental impact, and economic development. Document all EU decisions to the DDP using the list in Exhibit 300-6 as a guide for the content. The cost of the improvement must always be considered when making EU decisions. EU examples into the project, document this decision with a memo from the region Project Development Engineer that is included in the DDP. For an overview of design policy changes, consult the Detailed Chronology of Design Policy Changes Affecting Shelved Projects: www.wsdot.wa.gov/design/policy/default.htm

(1) Alternative Project Delivery Methods

Design Approval applies to projects delivered using alternative means, including design-build projects. Design documentation begins in the project scoping phase and continues through the life of the design-build project. This documentation is thus started by WSDOT and is completed by the design-builder. Since Design Approval is related to project scoping, this milestone may very well be accomplished prior to issuing a Design-Build Request for Proposal (see Exhibit 110-1). However, the design-builder shall refer to the RFP for direction on approval milestones.

300.08 Project Development Approval

When all project development documents are completed and approved, Project Development Approval is granted by the approval authority designated in Exhibit 300-2. The Project Development Approval becomes part of the DDP. (See 300.04 and Exhibit 300-5 for design documents that may lead to Project Development Approval.) Exhibits 300-2 through 300-4 provide approval levels for project design and PS&E documents.

The following items must be approved prior to Project Development Approval:

- Required environmental documents
- Design Approval documents (and any supplements)
- Updated Design Variance Inventory (all project variances)
- Cost estimate
- Stamped cover sheet (project description)

Project Development Approval remains valid for three years. Evaluate policy changes or revised design criteria that are adopted by the department during this time to determine whether these changes would have a significant impact on the scope or schedule of the project. If it is determined that these changes will not be incorporated into the project, document this decision with a memo from the region Project Development Engineer that is included in the DDP. For an overview of design policy changes, consult the Detailed Chronology of Design Policy Changes Affecting Shelved Projects at: www.wsdot.wa.gov/design/policy/default.htm

(1) Alternative Project Delivery Methods

For projects delivered using alternative methods, such as design-build, the design-builder shall refer to the project RFP for specification on final and intermediate deliverables and final records for the project. Project Development Approval is *required* prior to project completion.

It is a prudent practice to start the compilation of design documentation early in a project and to acquire Project Development Approval before the completion of the project. At the start of a project, it is critical that WSDOT project administration staff recognize the importance of all required documentation and how it will be used in the design-build project delivery process.

300.09 Process Review

The process review is done to provide reasonable assurance that projects are prepared in compliance with established policies and procedures and that adequate records exist to show compliance with state and federal requirements. Process reviews are conducted by WSDOT, FHWA, or a combination of both.

The design and PS&E process review is performed in each region at least once each year by the HQ Design Office. The documents used in the review process are the Design Documentation Checklist, the PS&E Review Checklist, and the PS&E Review Summary. These are generic forms used for all project reviews. Copies of these working documents are available for reference when assembling project documentation. The HQ Design Office maintains current copies at:
www.wsdot.wa.gov/design/projectdev

Each project selected for review is examined completely and systematically beginning with the scoping phase (including planning documents) and continuing through contract plans and, when available, construction records and change orders. Projects are normally selected after contract award. For projects having major traffic design elements, the HQ Maintenance and Operations Programs' Traffic Operations Office is involved in the review. The WSDOT process reviews may be held in conjunction with FHWA process reviews.

The HQ Design Office schedules the process review and coordinates it with the region and FHWA.

(a) **Process Review Agenda**

A process review follows this general agenda:

1. Review team meets with region personnel to discuss the object of the review.
2. Review team reviews the design and PS&E documents, construction documents, and change orders (if available) using the checklists.
3. Review team meets with region personnel to ask questions and clarify issues of concern.
4. Review team meets with region personnel to discuss findings.
5. Review team submits a draft report to the region for comments and input.
6. If the review of a project shows a serious discrepancy, the region design authority is asked to report the steps that will be taken to correct the deficiency.
7. Process review summary forms are completed.
8. Summary forms and checklists are evaluated by the State Design Engineer.
9. Findings and recommendations of the State Design Engineer are forwarded to the region design authority for action and/or information within 30 days of the review.

Project Design	FHWA Oversight Level	Deviation and Corridor/Project Approval[1][2]	EU Approval[2]	Design and Project Development Approvals
Interstate				
New/Reconstruction[3] Federal funds No federal funds	[4] [5]	FHWA	Region	FHWA[10]
Intelligent Transportation Systems (ITS) Improvement project over $1 million Preservation project	[6] [6]	HQ Design HQ Design	Region Region	HQ Design Region
All Other [7] Federal funds State funds Local agency funds	[6] [6] [5]	HQ Design	Region	Region
National Highway System (NHS)				
Managed access highway outside incorporated cities and towns or inside unincorporated cities and towns, or limited access highway	[6]	HQ Design	Region	Region
Managed access highway within incorporated cities and towns[8] Inside curb or EPS[9] Outside curb or EPS	[6] [6]	HQ Design HQ H&LP	Region N/A	Region City/Town
Non-National Highway System (Non-NHS)				
Improvement project on managed access highway outside incorporated cities and towns or within unincorporated cities and towns, or on limited access highway (Matrix lines 5-8 through 5-27)	N/A	HQ Design	Region	Region
Improvement project on managed access highway within incorporated cities and towns[8] Inside curb or EPS[9] Outside curb or EPS (Matrix lines 5-8 through 5-27)	N/A N/A	HQ Design HQ H&LP	Region N/A	Region City/Town
Preservation project on managed access highway outside incorporated cities and towns or within unincorporated cities and towns, or on limited access highway[11] (Matrix lines 5-1 through 5-7)	N/A	Region[12]	Region	Region
Preservation project on managed access highway within incorporated cities and towns[8][11] Inside curb or EPS[9] Outside curb or EPS (Matrix lines 5-1 through 5-7)	N/A N/A	Region HQ H&LP	Region N/A	Region City/Town

For table notes, see the following page.

Design Approval Level

Exhibit 300-2

FHWA = Federal Highway Administration
HQ = WSDOT Headquarters
H&LP = WSDOT Highways & Local Programs Office
EPS = Edge of paved shoulder where curbs do not exist

Notes:

[1] These approval levels also apply to deviation processing for local agency work on a state highway.
[2] See 300.04(4).
[3] For definition, see Chapter 1100.
[4] Requires FHWA review and approval (full oversight) of design and PS&E submitted by HQ Design Office.
[5] To determine the appropriate oversight level, FHWA reviews the Project Summary (or other programming document) submitted by the HQ Design Office or by WSDOT Highways & Local Programs through the HQ Design Office.
[6] FHWA oversight is accomplished by process review (see 300.09).
[7] Reduction of through lane or shoulder widths (regardless of funding) requires FHWA review and approval of the proposal, except shoulder reductions as allowed by 1140.09 for seismic retrofit projects.
[8] Applies to the area within the incorporated limits of cities and towns.
[9] Includes raised medians.
[10] FHWA will provide Design Approval prior to NEPA Approval, but will not provide Project Development Approval until NEPA is complete.
[11] For Bridge Replacement projects in the Preservation program, follow the approval level specified for Improvement projects.
[12] For guidance on access deviations, see Chapters 530 and 540.

Design Approval Level
Exhibit 300-2 (continued)

Item	Approval Authority		
	Region	HQ	FHWA
Program Development			
Work Order Authorization		X	X[1]
Public Hearings			
Corridor Hearing Summary		X[2]	
Design Summary		X[3]	
Access Hearing Plan		X[4]	
Access Findings and Order		X[5]	
Environmental by Classification			
Environmental Classification Summary (ECS) NEPA			X
Class I NEPA (EIS)		[7]	X
Class I SEPA (EIS)		X	
Class II NEPA – Categorical Exclusion (CE)* (Per MOU)	X		
Class II NEPA – Documented Categorical Exclusion (DCE)	[6]		X
Class II SEPA – Categorical Exemption (CE)	X		
Class III NEPA – Environmental Assessment (EA)		[7]	X
SEPA Checklist	X		
Design			
Experimental Features		X	X[9]
Environmental Review Summary	X		
Final Design Decisions	X	X[3]	
Final Project Definition		X[10]	
Interstate Interchange Justification Report		[7]	X
Non-Interstate Interchange Justification Report		X	
Break in Partial or Modified Limited Access		X	
Intersection Plans	X[11]		
Right of Way Plans	[12]	X	
Monumentation Map	X		
Materials Source Report		X[13]	
Pavement Determination Report		X[13]	
Roundabout Geometric Design (see Chapter 1320 for guidance)	X		

For table notes, see the following page.

Approvals
Exhibit 300-3

Item	Approval Authority		
	Region	HQ	FHWA
Design (continued)			
Resurfacing Report		X[13]	
Signal Permits	X[14]		
Geotechnical Report		X[13]	
Tied Bids	X[15]		X[9][15]
Bridge Design Plans (Bridge Layout)	X	X	
Hydraulic Report	X[16]	X[16]	
Preliminary Signalization Plans		X[6][20]	
Signalization Plans	X[22]		
Illumination Plans	X[22]		
Intelligent Transportation System (ITS) Plans	X[22]		
ITS Project Systems Engineering Review Form (Exhibit 1050-2a)	X[22]		X[1]
Rest Area Plans		X	
Roadside Restoration Plans	X[18]	X[19]	
Structures Requiring TS&Ls		X	X
Planting Plans	X[18]	X[19]	
Grading Plans	X		
Continuous Illumination – Main Line		X[20]	
Tunnel Illumination		X[20]	
High Mast Illumination		X[20]	
Project Change Request Form	X[21]	X[21]	
Work Zone Transportation Management Plan/Traffic Control Plan	X[22]		
Public Art Plan – Interstate (see Chapter 950)	X[18][23]	X[19][23]	X[9][19][23]
Public Art Plan – Non-Interstate (see Chapter 950)	X[18][23]	X[19][23]	
ADA Maximum Extent Feasible Document (see Chapter 1510)	X	X	

X Normal procedure * If on the preapproved list

Notes:

[1] Federal-aid projects only.
[2] Approved by Environmental and Engineering Programs Director.
[3] Approved by State Design Engineer.
[4] Approved by Right of Way Plans Manager.
[5] Refer to Chapter 210 for approval requirements.
[6] Final review & concurrence required at the region level prior to submittal to approving authority.
[7] Final review & concurrence required at HQ prior to submittal to approving authority.
[9] Applies to new/reconstruction projects on Interstate routes.
[10] Approved by HQ Project Control & Reporting.
[11] Include channelization details.
[12] Certified by the responsible professional licensee.
[13] Submit to HQ Materials Laboratory for review and approval.
[14] Approved by Regional Administrator or designee.
[15] See 23 CFR 635.111.
[16] See the *Hydraulics Manual* for approvals levels.
[18] Applies only to regions with a Landscape Architect.
[19] Applies only to regions without a Landscape Architect.
[20] Approved by State Traffic Engineer.
[21] Consult HQ Project Control & Reporting for clarification on approval authority.
[22] Region Traffic Engineer.
[23] The State Bridge and Structures Architect reviews and approves the public art plan (see Chapter 950 for further details on approvals).

Approvals
Exhibit 300-3 (continued)

Item	New/Reconstruction (Interstate only)	NHS and Non-NHS
DBE/training goals* **	(a)	(a)
Right of way certification for federal-aid projects	FHWA(b)	FHWA(b)
Right of way certification for state-funded projects	Region(b)	Region(b)
Railroad agreements	(c)	(c)
Work performed for public or private entities*	[1][2]	Region[1][2]
State force work*	FHWA[3](d)	Region[3](d)
Use of state-furnished stockpiled materials*	FHWA[4]	FHWA[4]
Stockpiling materials for future projects*	FHWA[4]	FHWA[4]
Work order authorization	[5](d)	[5](d)
Ultimate reclamation plan approval through DNR	Region	Region
Proprietary item use*	FHWA[4]	[4](c)
Mandatory material sources and/or waste sites*	FHWA[4]	Region[4]
Nonstandard bid item use*	Region	Region
Incentive provisions	FHWA	(e)
Nonstandard time for completion liquidated damages*	FHWA(e)	(e)
Interim liquidated damages*	(f)	(f)

Notes:

[1] This work requires a written agreement.
[2] Region approval subject to $250,000 limitation.
[3] Use of state forces is subject to $60,000 limitation and $100,000 in an emergency situation, as stipulated in RCWs 47.28.030 and 47.28.035.
[4] Applies only to federal-aid projects; however, document for all projects.
[5] Prior FHWA funding approval required for federal-aid projects.

Region or Headquarters Approval Authority:

(a) Office of Equal Opportunity
(b) HQ Real Estate Services Office
(c) HQ Design Office
(d) Project Control & Reporting Office
(e) HQ Construction Office
(f) Transportation Data Office

References:

**Plans Preparation Manual*

***Advertisement and Award Manual*

PS&E Process Approvals
Exhibit 300-4

Document[1]	Required for FHWA Oversight
Project Definition	X
Design Decisions Summary	X
Environmental Review Summary	X
Design Variance Inventory (and supporting information for DEs, EUs not upgraded, and deviations)[2]	X
Cost estimate	X
SEPA & NEPA documentation	X
Design Clear Zone Inventory (see Chapter 1600)	X
Interchange plans, profiles, roadway sections	X
Interchange justification report (if requesting new or revised access points)	X
Corridor or project analysis (see Chapter 1100)	X
Traffic projections and analysis	
Collision analysis	
Right of way plans	
Work zone traffic control strategy	
Record of Survey or Monumentation Map	
Documentation of decisions to differ from WSDOT design guidance	
Documentation of decisions for project components for which there is no WSDOT design guidance	
Paths and Trails Calculations[3]	
Project Change Request Forms	

Notes:

[1] For a complete list, see the Design Documentation Checklist.

[2] Required for all highways.

[3] See the *Plans Preparation Manual*.

Common Components of Design Documentation Package

Exhibit 300-5

Chapter 620 Design of Pavement Structure

620.01 General

Detailed criteria and methods that govern pavement design are in the Washington State Department of Transportation (WSDOT) *Pavement Policy*:
www.wsdot.wa.gov/biz/mats/Apps/DraftWSDOTPavementPolicy2-2-10.pdf

The pavement design for all Design-Build project RFPs will be conducted by the State Materials Lab, Pavement Division.

620.02 Estimating Tables

Exhibits 620-1 through 620-5h are to be used when detailed estimates are required. They are for pavement sections, shoulder sections, stockpiles, and asphalt distribution. Prime coats and fog seal are in Exhibit 620-2a.

Type of Material	Unit Dry Weight: Truck Measure lb/cy	Truck Measure T/cy	Compacted on Roadway lb/cy	Compacted on Roadway T/cy
Ballast	3,100	1.55	3,900	1.95
Crushed Surfacing Top Course	2,850	1.43	3,700	1.85
Crushed Surfacing Base Course	2,950	1.48	3,700	1.85
Screened Gravel Surfacing			3,700	1.85
**Gravel Base			3,400 – 3,800	1.70 – 1.90
Permeable Ballast			2,800	1.40
Maintenance Sand ⅜” – 0	2,900	1.45		
Mineral Aggregate 2” – 1”	2,600	1.30		
Mineral Aggregate 1¾” – ¾”	2,600	1.30		
Mineral Aggregate 1½” – ¾”	2,550	1.28		
Mineral Aggregate 1” – ¾”	2,500	1.25		
Mineral Aggregate ¾” – ½”	2,400	1.20		
Mineral Aggregate 1¼” – ¼’”	2,600	1.30		
Mineral Aggregate 1” – ¼”	2,600	1.30		
Mineral Aggregate ⅞” – ¼”	2,550	1.28		
Mineral Aggregate ¾” – ¼”	2,500	1.25		
Mineral Aggregate ⅝” – ¼”	2,650	1.33		
Mineral Aggregate ½” – ¼” or #4	2,600	1.30		
Mineral Aggregate ¼” or #4 – 0	2,900	1.45		
Concrete Aggr. No. 2 (1 ¼” - #4)	3,000	1.50		
Concrete Sand (Fine Aggregate)	2,900	1.45		
Crushed Cover Stone	2,850	1.43		
** 3,700 lb/cy (1.85 tons/cy) is recommended as the most suitable factor; however, if the grading approaches the coarseness of ballast, the factor would approach 3,800 lb/cy (1.90 tons/cy), and if the grading contains more than 45% sand, the factor would decrease, approaching 3,400 lb/cy (1.70 tons/cy) for material that is essentially all sand.				

Notes:

- Weights shown are dry weights and corrections are required for water contents.
- The tabulated weights for the materials are reasonably close; however, apply corrections in the following order:

For specific gravity: $$\text{Wt.} = \frac{\text{tabular wt. x specific gravity on surface report}}{2.65}$$

For water content: Wt. = tabular wt. x (1 + free water % in decimals)

- If material is to be stockpiled, increase required quantities by 10% to allow for waste.
- Direct attention to the inclusion of crushed surfacing top course material that may be required for keystone when estimating quantities for projects having ballast course.

Estimating: Miscellaneous Tables

Exhibit 620-1

Include the Structural Capacity Report in the Design Documentation Package (DDP).

The considerations used to evaluate the structural capacity of a bridge are as follows:

1. On National Highway System (NHS) routes (including Interstate routes):
   - The operating load rating is at least 36 tons (which is equal to HS-20).
   - The bridge is not permanently posted for legal weight vehicles.
   - The bridge is not permanently restricted for vehicles requiring overweight permits.
2. On non-NHS routes:
   - The bridge is not permanently posted for legal weight vehicles.
   - The bridge is not permanently restricted for vehicles requiring overweight permits.

(2) Bridge Widths for Structures

(a) **New Structures**

Full design level widths are provided on all new structures (see Chapter 1140). All structures on city or county routes crossing over a state highway must conform to the *Local Agency Guidelines*. Use local city or county adopted and applied criteria when their minimum width exceeds state criteria.

(b) **Existing Structures**

For guidance on existing structures, see the design matrices in Chapter 1100.

(3) Horizontal Clearance

Horizontal clearance for structures is the distance from the edge of the traveled way to bridge piers and abutments, traffic barrier ends, or bridge end embankment slopes. Minimum distances for this clearance vary depending on the type of structure. (See Chapters 1600 and 1610 and the *Bridge Design Manual* for guidance on horizontal clearance.)

For structures involving railroads, contact the HQ Design Office Railroad Liaison.

(4) Medians

For multilane highways, the minimum median widths for new bridges are as shown in Chapters 1130 and 1140. Evaluate the need for an opening versus spanning or shielding the opening (examples: decking, netting, or railing treatments) when the open median area between new bridges is 26 feet or less.

The preferred treatment, when cost-effective, is to provide a new single structure that spans the area between the roadways. When this is impracticable, consider widening the two bridges on the median sides to reduce the open area to 6 inches. When neither option is practicable, consider installing netting or other elements to enclose the area between the bridges. An open area between structures may be required for bridge inspection. Coordinate with the Bridge and Structures and Maintenance offices. Document this evaluation in the Design Documentation Package.

(5) Vertical Clearance

Vertical clearance is the critical height under a structure that will accommodate vehicular and rail traffic based on its design characteristics. This height is the least height available from the lower roadway surface (including usable shoulders) or the plane of the top of the rails to the bottom of the bridge. Usable shoulders are the design shoulders for the roadway and do not include paved widened areas that may exist under the structure.

Construction of new bridges and the reconstruction or widening of existing structures often require the erection of falsework across the traveled way of a highway. The erection of this falsework can reduce the vertical clearance for vehicles to pass under the work area. The potential for accidents to occur by hitting this lower construction stage falsework is increased.

(a) **Vertical Falsework Clearance for Bridges Over Highways**

1. On all routes that require a 16-foot-6-inch vertical clearance, maintain the 16-foot-6-inch clearance for falsework vertical clearance.
    - On structures that currently have less than a 16-foot-6-inch vertical clearance for the falsework envelope, maintain existing clearance.
    - On new structures, maintain the falsework vertical clearance at least to those of the minimum vertical clearances referenced below.
2. Any variance from the above must be approved by the Regional Administrator or designee in writing and made a part of the Project File.

(b) **Minimum Clearance for New Structures**

For new structures, the minimum vertical clearances are as follows:

1. **Bridge Over a Roadway**

    The minimum vertical clearance for a bridge over a roadways is 16.5 feet.

2. **Bridge Over a Railroad Track**

    The minimum vertical clearance for a bridge over a railroad track is 23.5 feet (see Exhibit 720-2). A lesser clearance may be negotiated with the railroad company based on certain operational characteristics of the rail line; however, any clearance less than 22.5 feet requires the approval of the Washington State Utilities and Transportation Commission (WUTC) per WAC 480-60. Vertical clearance is provided for the width of the railroad clearance envelope. Coordinate railroad clearance issues with the HQ Design Office Railroad Liaison.

3. **Pedestrian Bridge Over a Roadway**

    The minimum vertical clearance for a pedestrian bridge over a roadway is 17.5 feet.

(d) **Signing**

Low-clearance warning signs are necessary when the vertical clearance of an existing bridge is less than 15 feet 3 inches. Refer to the *Manual on Uniform Traffic Control Devices* and the *Traffic Manual* for other requirements for low-clearance signing.

(e) **Coordination**

The Interstate System is used by the Department of Defense (DOD) for the conveyance of military traffic. The Military Traffic Management Command Transportation Engineering Agency (MTMCTEA) represents the DOD in public highway matters. The MTMCTEA has an inventory of vertical clearance deficiencies over the Interstate System in Washington State. Contact the MTMCTEA, through the Federal Highway Administration (FHWA), if either of the following changes is proposed to these bridges:

- A project would create a new deficiency of less than a 16.0-foot vertical clearance over an Interstate highway.
- The vertical clearance over the Interstate is already deficient (less than 16.0 feet) and a change (increase or decrease) to vertical clearance is proposed.

Coordination with MTMCTEA is required for these changes on all rural Interstate highways and for one Interstate route through each urban area.

(6) Liquefaction Impact Considerations

To determine the amount of settlement and the potential for the soil to flow laterally during the design level earthquake due to liquefaction, an analysis performed by the HQ Geotechnical Services Division is needed for each bridge project site location. The information collected is used by bridge engineers to determine the bridge's capability to withstand the movement and loading in a seismic event and to explore other foundation mitigation options not necessitating total bridge replacement.

The HQ Bridge and Structures Office, in collaboration with the HQ Geotechnical Services Division, evaluates bridge-widening projects involving liquefiable soils and recommends appropriate liquefaction mitigation. The following guidance is intended to assist designers in making project decisions that balance project risks with project and program budget realities.

(a) **Design Decision Considerations**

The following design decision guidance is generally in order of the complexity of project decision making, starting with the most straightforward through the most complex.

1. New bridges will be designed to current seismic and liquefaction standards.
2. Bridge widening that does not require new substructure (a new column) does not require consideration of liquefaction mitigation.

3. Widening that involves any new substructure will require a settlement and lateral loading analysis by the HQ Bridge and Structures Office in collaboration with the HQ Geotechnical Services Division. Each analysis will be unique to the conditions at that particular bridge site.
   a. If a bridge has less than 15 years of its service life remaining, no liquefaction mitigation is necessary according to FHWA guidelines.
   b. If the HQ Geotechnical Services Division analysis demonstrates that the differential settlement induced by liquefaction between the existing bridge and the widened portion will not create forces great enough to cause collapse of the existing bridge, and if lateral loading and movement caused by the liquefaction is minimal, liquefaction mitigation may not be necessary. The decision must be endorsed by the State Geotechnical Engineer, the State Bridge Engineer and the Regional Administrator. The decision and rationale are to be included in the Design Documentation Package.
   c. If the HQ Geotechnical Services Division analysis demonstrates that the differential settlement induced by liquefaction or the lateral loading and movement will be substantial and these movements will result in the collapse of the existing and widened portion of the bridge, additional analysis and documentation are necessary for the project to proceed. A preliminary design and estimate of the mitigation necessary to prevent collapse needs to be performed. Consider alternative designs that eliminate or reduce the need for the widening.

(b) **Deferring Liquefaction Mitigation**

1. **Consideration of Deferment**

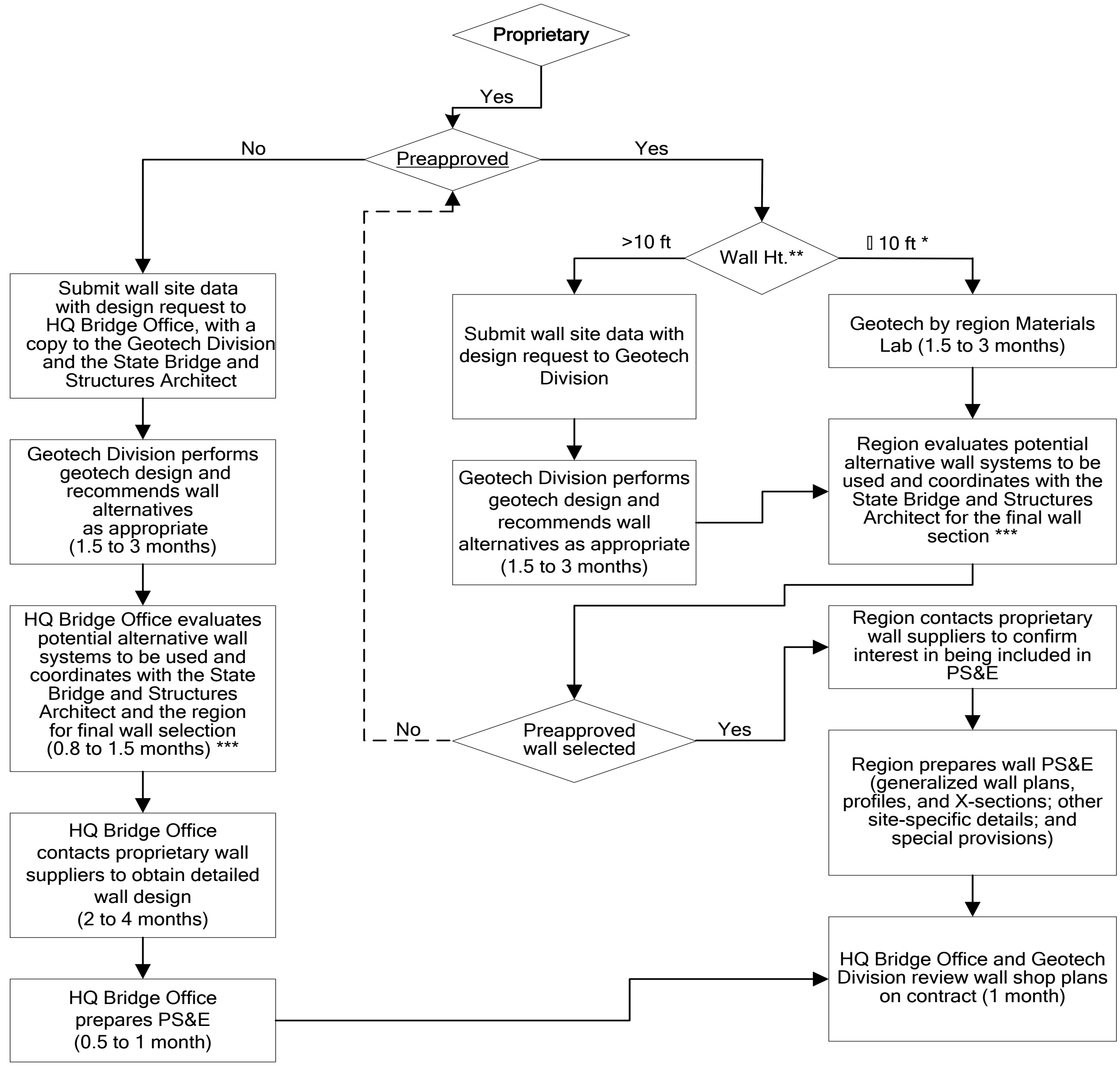
   If an alternative design concept is not feasible given the constraints of the project or program, consideration may be given to defer the liquefaction mitigation. Project-related structural retrofits that are deferred because of scope-related issues are to be considered for implementation through the WSDOT seismic retrofit program. The operating characteristics of the roadway and overall estimated cost of the liquefaction mitigation is typically considered in making that decision.

2. **Deferment Requires Approval**

   A decision to defer the mitigation to the seismic retrofit program is made by the WSDOT Chief Engineer after reviewing and considering the alternatives. The decision is to be included in the Design Documentation Package. A memo from the Chief Engineer will be provided to the structural designer of record documenting the agency's decision to defer the mitigation work to the WSDOT seismic retrofit program. A copy of the memo is to be included in the Design Documentation Package (DDP) and the contract general notes.

(7) Pedestrian and Bicycle Facilities

When pedestrians or bicyclists are anticipated on bridges, provide facilities consistent with guidance in Chapters 1510, 1515, and 1520.



Notes:

"HQ Bridge Office" refers to the WSDOT HQ Bridge and Structures Office.

"Geotech Division" refers to the WSDOT Geotechnical Division at Headquarters.

"State Bridge and Structures Architect" refers to the Architecture Section, HQ Bridge and Structures Office.

Regarding time estimates:

- Assumes no major changes in the wall scope during design.
- Actual times may vary depending on complexity of project.
- Contact appropriate design offices for more accurate estimates of time.

Legend:

Region provides courtesy copy of geotechnical report to Geotechnical Services Division.

*Assumes soft or unstable soil not present and wall does not support other structures.

**The preapproved maximum wall height is generally 33 feet. Some proprietary walls might be less. (Check with the HQ Bridge and Structures Office.)

***If the final wall selected is a different type than assumed, go back through the design process to ensure that all the steps have been taken.

Retaining Wall Design Process: Proprietary

Exhibit 730-13b

- There are three or more successive interchanges with an average spacing of 1½ miles or less, measured from the center of each interchange or a common point such as a major crossroad.
- The segment is in an urban area.
- A nighttime collision frequency condition exists.
- A benefit/cost analysis between the required and full (continuous) illumination indicates a value-added condition with the addition of continuous illumination.

(b) On the main line of highways without full limited access control, consider full (continuous) illumination if the segment of highway is in a commercial area and either a diminished level of service exists or a nighttime collision frequency exists and an engineering study indicates that nighttime driving conditions will be improved.

(3) Ramps

At ramps, consider additional illumination when a diminished level of service exists for the ramps and any of the following conditions is present:

- The ramp alignment and grade are complex.
- There are routine queues of five or more vehicles per lane at the ramp terminal during the nighttime peak hour due to traffic control features.
- A nighttime collision frequency condition exists.
- The criteria for continuous main line illumination have been satisfied.

(4) Highway-to-Highway Ramp Connections

Provide the necessary number of light standards to illuminate highway-to-highway ramps that connect partial or modified limited access freeway systems or managed access highway systems, from the exit ramp gore area to the main line merge area. For an example of the ramp connection, see Exhibit 1040-4.

(5) Crossroads

At crossroads, consider additional illumination when a diminished level of service exists and a nighttime collision frequency exists. Also, consider additional illumination if the crossroad is in a short tunnel, an underpass, or a lid.

(6) Intersections Without Turn-Lane Channelization

Consider illumination of intersections without turn-lane channelization if a nighttime collision frequency requirement is satisfied or the intersection meets warrants for left-turn channelization (see Exhibit 1040-11).

(7) Short Tunnels, Underpasses, or Lids

Consider illumination of short tunnels, underpasses, or lids if portal conditions result in brightness that is less than the measured daytime brightness of the approach roadway divided by 15 and the length to vertical clearance ratio is 10:1 or greater.

(8) Work Zones and Detours

Consider temporary illumination of the highway through work zones and detours when changes to the highway alignment or grade remain in place during nighttime hours and when the following conditions may be present (see Exhibit 1040-24):

- Nonstandard roadway features such as narrow lanes, narrow shoulders, or substandard shy distance to barriers or structures.
- The temporary alignment includes abrupt changes in highway direction or lane shifts with substandard lane shift tapers.
- Other unusual highway features such as abrupt lane edge drop-offs, sudden changes in pavement conditions, or temporary excavation or trenching covers.
- There is an anticipation of heavy construction truck traffic, possibly requiring flaggers, entering and exiting the highway during nighttime hours.

For further information on work zones, see Chapter 1010.

(9) Transit Stops

The responsibility for lighting at transit stops is shared with the transit agency. Consider illuminating transit stops with shelters as they usually indicate greater passenger usage. Negotiation with the transit agencies is required for the funding and maintenance of this illumination. Negotiating a memorandum of understanding (MOU) with each transit agency is preferred over spot negotiations. If the transit agency is unable or unwilling to participate in the funding and maintenance of the illumination, consider a single light standard positioned to illuminate both the transit pullout area and the loading area.

(10) Bridges

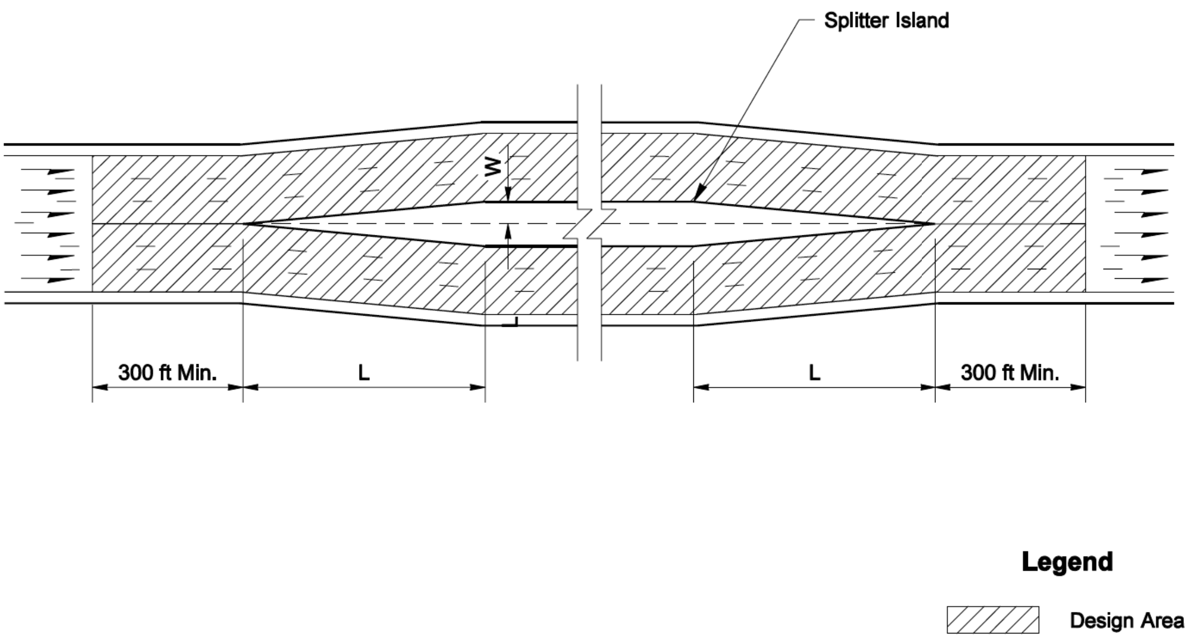
Justification for illuminating the roadway/sidewalk portion of bridges is the same as that for highways on either end of the bridge with or without full limited access control, as applicable. Justification for illuminating the architectural features of a bridge structure requires the approval of the State Traffic Engineer. For justification for illuminating pedestrian walkways or bicycle trails under a bridge, see 1040.06(12).

(11) Railroad Crossing Without Gates or Signals

Consider the illumination of railroad crossings without gates or signals when:

- The collision history indicates that motorists experience difficulty in seeing trains or control devices.
- There are a substantial number of rail operations conducted during nighttime hours.
- The crossing is blocked for long periods due to low train speeds.
- The crossing is blocked for long periods during the nighttime.

For further information, see the MUTCD.

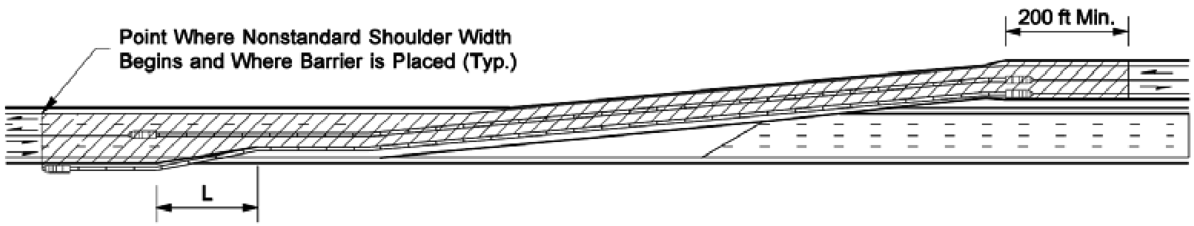


For speeds 45 mph or more: L = WS
For speeds less than 45 mph: $L = WS^2/60$

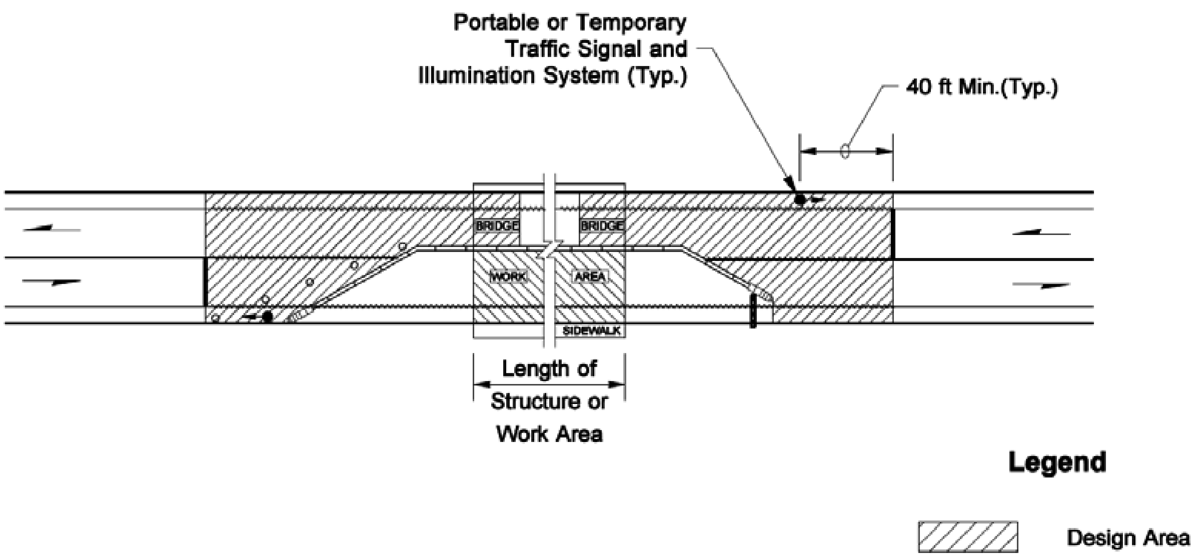
L = Taper in feet
W = Width of offset in feet
S = Posted speed

Note:
For temporary work zone plan applications, a site-specific traffic control plan is required. Refer to Chapters 1610 and 1620 for traffic barrier and attenuator information, Chapter 1010 for work zone information, and Chapter 1020 for signing information.

Traffic Split Around an Obstruction
Exhibit 1040-23



Detour Traffic



Lane Closure With Barrier and Signals Without Flaggers or Spotters

One-direction closure shown/other direction closure typical.

Note:

For temporary work zone plan applications, a site-specific traffic control plan is required. Refer to Chapters 1610 and 1620 for traffic barrier and attenuator information, Chapter 1010 for work zone information, and Chapter 1020 for signing information. Refer to the MUTCD Typical Application 12 for additional details.

Construction Work Zone and Detour

Exhibit 1040-24

Chapter 1050 Intelligent Transportation Systems

1050.01 General

Intelligent Transportation Systems (ITS) improve transportation safety and mobility and enhance productivity through the use of advanced communications technologies and their integration into the transportation infrastructure and in vehicles. These systems encompass a broad range of wireless and wire line communications-based information and electronics technologies.

The purpose and direction of ITS for the Washington State Department of Transportation (WSDOT) can be found in the Statewide Intelligent Transportation Systems (ITS) Plan. A current copy of this plan can be obtained online (see References) or by contacting the State Traffic Engineer. The plan identifies the current and long-term ITS needs to meet the objectives identified in Moving Washington, WSDOT's program to fight traffic congestion.

The Statewide ITS Plan is a comprehensive document that discusses:

- The history of ITS deployment in Washington.
- How ITS meets WSDOT's transportation vision and goals.
- The current state of ITS deployment.
- WSDOT's near-term ITS plans.
- How projects are prioritized.
- What long-term ITS issues WSDOT needs to begin planning for.

Due to the dynamic nature of ITS, printed guidance is soon outdated. Detailed design guidance and current practices are located on the following websites. For additional information and direction, contact the region Traffic Engineer or the State Traffic Engineer (www.wsdot.wa.gov/design/traffic/).

1050.02 References

23 Code of Federal Regulations (CFR), Part 940, Intelligent Transportation System Architecture and Standards

USDOT's *Systems Engineering for Intelligent Transportation Systems*, FHWA-HOP-07-069, January 2007
http://ops.fhwa.dot.gov/publications/seitsguide/index.htm

Manual on Uniform Traffic Control Devices for Streets and Highways, USDOT, FHWA; as adopted and modified by Chapter 468-95 WAC "Manual on uniform traffic control devices for streets and highways" (MUTCD)
www.wsdot.wa.gov/publications/manuals/mutcd.htm

SAFETEA-LU (Safe Accountable Flexible Efficient Transportation Equity Act: A Legacy for Users)
http://www.fhwa.dot.gov/safetealu/index.htm

FHWA's and Caltrans' *Systems Engineering Guidebook for ITS*
http://www.fhwa.dot.gov/cadiv/segb/

WSDOT Northwest Region Traffic Design
http://www.wsdot.wa.gov/northwest/trafficdesign

WSDOT Statewide Intelligent Transportation Systems (ITS) Plan, April 2009
http://wwwi.wsdot.wa.gov/maintops/traffic/pdf/itsplan32409.pdf

WSDOT Traffic Design
http://www.wsdot.wa.gov/design/traffic/

1050.03 Systems Engineering

Systems engineering is a systematic process that was developed specifically for complex technology projects. Systems engineering processes are required on all highway trust fund projects, as noted in 23 CFR 940.11. It is WSDOT policy that systems engineering processes be used on all ITS projects regardless of the funding source.

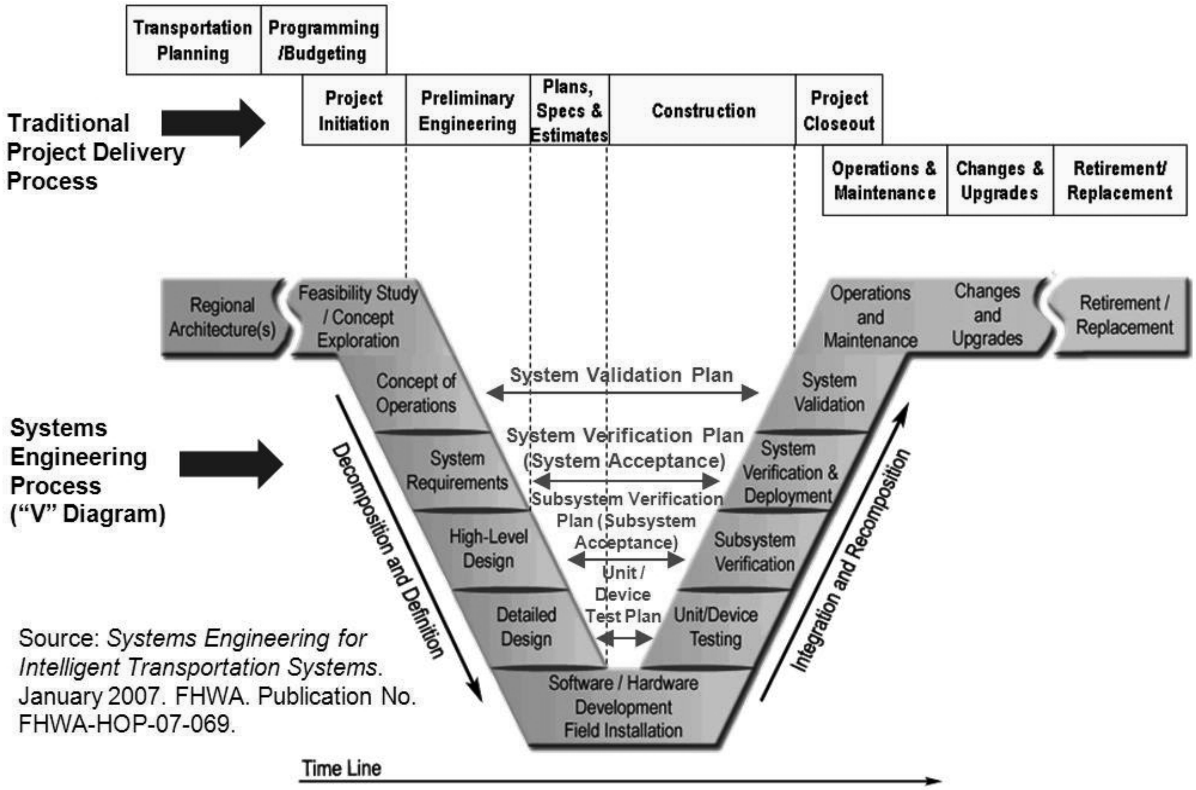
Using systems engineering on ITS projects has been shown to increase the likelihood of project success (that is, projects that are completed on time and on budget, meet stakeholder/project sponsor expectations, and are efficient to operate and maintain).

The systems engineering process, often referred to as the "V" diagram, is shown in Exhibit 1050-1. As shown in the exhibit, the systems engineering process contains a number of steps that are not included in the traditional project delivery process.

An ITS project begins in the upper left side of the "V" diagram and progresses down the "V" and up the right side. Upon reaching the upper right corner, reverse the process to ensure the project being completed meets the initial requirements.

During the component-level "Detailed Design," specific subsystems and/or components (such as wireless communications, variable message signs, cameras, roadway weather information systems, highway advisory radio systems, or software) should be identified as requiring specialized knowledge and skills. These issues are to be coordinated between the Project Engineer and the region Traffic Engineer.

Construction oversight and approvals are addressed in the systems engineering process as you validate/verify the right side of the "V" diagram with the left side. The key to successful construction oversight is traceability. Trace each step on the right side of the "V" diagram back to a requirement on the left side.



Systems Engineering Process ("V" Diagram)
Exhibit 1050-1

23 CFR 940 defines the minimum requirements for fulfilling the systems engineering process on a project. It is WSDOT policy that these requirements apply to all ITS projects regardless of the funding source. They include the following:

- Identify the portions of the regional ITS architecture being implemented. Refer to the ITS architecture or regional planning document.
- Identify the roles and responsibilities of participating agencies.
- Define the system requirements.
- Provide an analysis of alternative system configurations and technology options to meet requirements.
- Identify procurement options.
- Identify applicable ITS standards and testing procedures.
- Delineate the procedures and resources necessary for operations and management of the system.

Completing the "ITS Project Systems Engineering Review Form" (see Exhibit 1050-2) will fulfill these minimum requirements for a project. However, the level of systems engineering used for a project should be on a scale commensurate with the scope, size, and risk of the project.

For relatively small, low-risk ITS projects (such as adding a ramp meter to an existing ramp-metering system), completing the "ITS Project Systems Engineering Review Form" is a sufficient level of systems engineering. Conversely, relatively large, high-risk ITS projects (such as developing a new custom software system for sharing control of traffic signal systems across multiple agencies) should follow and document each step of the "V" diagram.

Include all ITS systems engineering documentation in the Design Documentation Package (DDP). All systems engineering documentation requires region Traffic Engineer approval. As each phase of an ITS project is completed, a report is to be submitted to the region Traffic Engineer. Approvals for ITS project are dependent upon with project complexity and cost. (See Chapter 300 for ITS project approval requirements.)

Systems engineering costs are to be estimated and incorporated into the construction engineering (CE) and project engineering (PE) portions of the construction estimate.

1050.04 Documentation

For the list of documents required to be preserved in the Design Documentation Package and the Project File, see the Design Documentation Checklist:
www.wsdot.wa.gov/design/projectdev/

This form (or a reasonable facsimile) must be completed for all Intelligent Transportation Systems (ITS) projects and included in the DDP. Submit the form to FHWA with the construction authorization request for all federal-aid projects that include ITS.

Name of Project:

Regional ITS Architecture:

1. **Identify the portions of the Regional ITS Architecture being implemented. Is the project consistent with the architecture? Are revisions to the architecture required?**

   Identify which user services, physical subsystems, information flows, and market packages are being completed as part of the project and explain how these pieces are part of the regional architecture.

2. **Identify the participating agencies, their roles and responsibilities, and concept of operations:**

   For the user services to be implemented, define the high-level operations of the system, including where the system will be used; functions of the system; performance parameters; the life cycle of the system; and who will operate and maintain the system. Establish requirements or agreements on information sharing and traffic device control responsibilities. The regional architecture operational concept is a good starting point for discussion.

3. **Define the system requirements:**

   Based on the above concept of operations, define the "what" and not the "how" of the system. During the early stages of the systems engineering process, break down the process into detailed requirements for eventual detailed design. The applicable high-level functional requirements from the regional architecture are a good starting point for discussion. A review of the requirements by the project stakeholders is recommended.

4. **Provide an analysis of alternative system configurations and technology options to meet requirements:**

   The analysis of system alternatives should outline the strengths and weaknesses, technical feasibility, institutional compatibility, and life cycle costs of each alternative. The project stakeholders should have input in choosing the preferred solution.

ITS Project Systems Engineering Review Form

Exhibit 1050-2

5. **Identify procurement options:**

Some procurement (contracting) options to consider include: consultant design/low-bid contractor, systems manager, systems integrator, task order, and design/build. The decision regarding the best procurement option should consider the level of agency participation, compatibility with existing procurement methods, role of system integrator, and life cycle costs.

There are different procurement methods for different types of projects. If the project significantly meets the definition of construction, then construction by low-bid contract would be used. If the project significantly meets the definition of software development/ hardware acquisition (in other words, an information technology project), then follow the acquisition processes outlined in the WSDOT Purchasing Manual. This option includes services for systems integration, systems management, and design.

Contact the WSDOT HQ Traffic Office for additional guidance and procurement options.

6. **Identify the applicable ITS standards and testing procedures:**

Include documentation on which standards will be incorporated into the system design and justification for any applicable standards not incorporated. The standards report from the regional architecture is a good starting point for discussion.

7. **Delineate the procedures and resources necessary for operations and management of the system:**

In addition to the above concept of operations, document any internal policies or procedures necessary to recognize and incorporate the new system into the current operations and decision-making processes. Resources necessary to support continued operations, including staffing and training must also be recognized early and be provided for. Such resources must also be provided to support necessary maintenance and upkeep to ensure continued system viability.

ITS Project Systems Engineering Review Form Instructions

Exhibit 1050-2 (continued)

Washington State
Department of Transportation

TECHNICAL MANUAL

Design Manual

Volume 2 – Design Criteria

M 22-01.07

July 2010

Division 11 – Project Design Criteria
Division 12 – Geometrics
Division 13 – Intersections and Interchanges
Division 14 – HOV and Transit
Division 15 – Pedestrian and Bicycle Facilities
Division 16 – Roadside Safety Elements
Division 17 – Roadside Facilities

Environmental and Engineering Programs
Design Office

Americans with Disabilities Act (ADA) Information

Materials can be provided in alternative formats for persons with disabilities by contacting the ADA Compliance Officer via telephone at 360-705-7097 or by e-mail to Shawn Murinko at murinks@wsdot.wa.gov.

Title VI Notice to Public

It is Washington State Department of Transportation (WSDOT) policy to ensure no person shall, on the grounds of race, color, national origin, or sex, as provided by Title VI of the Civil Rights Act of 1964, be excluded from participation in, be denied the benefits of, or be otherwise discriminated against under any of its federally funded programs and activities. Any person who believes his/her Title VI protection has been violated may file a complaint with WSDOT's Office of Equal Opportunity (OEO). For Title VI complaint forms and advice, please contact OEO's Title VI Coordinator at 360-705-7098.

To get the latest information on WSDOT administrative and engineering manuals, sign up for e-mail updates for individual manuals at:
www.wsdot.wa.gov/publications/manuals/

Washington State Department of Transportation
Administrative and Engineering Publications
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E-mail: engrpubs@wsdot.wa.gov
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Volume 1 – Procedures Contents

Division 1 – General Information

Division 2 – Hearings, Environmental, and Permits

Division 4 – Surveying

Division 5 – Right of Way and Access Control

Division 6 – Soils and Paving

Division 9 – Roadside Development

Division 10 – Traffic Safety Elements

Division 11 – Project Design Criteria

Division 14 – HOV and Transit

Division 15 – Pedestrian and Bicycle Facilities

Division 17 – Roadside Facilities

Lane Width: Defined in Chapter 1140 (also see Chapters 1130, 1230, 1240, and 1360).

Shoulder Width: Defined in Chapter 1140 (also see Chapters 1130, 1230, and 1360). For shy distance requirements when barrier is present, see Chapter 1610.

Lane Transitions (pavement transitions): The rate and length of transition of changes in width of lanes (see Chapter 1210).

On/Off Connection: The widened portion of pavement at the end of a ramp connecting to a main lane of a freeway (see Chapter 1360).

Median Width: The distance between inside edge lines (see Chapters 1140 and 1230).

Cross Slope: Lane: The rate of elevation change across a lane. This element includes the algebraic difference in cross slope between adjacent lanes (see Chapters 1130 and 1230).

Cross Slope: Shoulder: The rate of elevation change across a shoulder (see Chapters 1130 and 1230).

Fill/Ditch Slopes: The downward slope from edge of shoulder to bottom of ditch or catch (see Chapters 1130 and 1230).

Access: The means of entering or leaving a public road, street, or highway with respect to abutting private property or another public road, street, or highway (see Chapter 520).

Clear Zone: The total roadside border area, starting at the edge of the traveled way, available for use by errant vehicles. This area may consist of a shoulder, a recoverable slope, a nonrecoverable slope, and/or a clear run-out area. The median is part of a clear zone (see Chapter 1600).

Signing, Delineation, Illumination, ITS: Signs, guideposts, pavement markings, lighting, and intelligent transportation systems equipment. (See Chapters 720 for bridge signs and 1020 for signing, Chapter 1030 for delineation, Chapter 1040 for illumination, and Chapter 1050 for ITS.)

Vertical Clearance: Defined in Chapter 720.

Basic Safety: The list of safety items is in Chapter 1120.

Bicycle and Pedestrian: Defined in Chapter 1510, Pedestrian Design Considerations, Chapter 1515, Shared-Use Paths, and Chapter 1520, Roadway Bicycle Facilities.

Bridges: Lane Width: The width of a lane on a structure (see Chapters 720, 1130, 1140, 1230, 1240, and 1360).

Bridges: Shoulder Width: The distance between the edge of traveled way and the face of curb or barrier, whichever is less (see Chapters 720, 1130, 1140, 1230, and 1360; also see Chapter 1610 for shy distance requirements).

Bridges/Roadway: Vertical Clearance: The minimum height between the roadway, including shoulder, and an overhead obstruction (see Chapter 720).

Bridges: Structural Capacity: The load-bearing ability of a structure (see Chapter 720).

Intersections/Ramp Terminals: Turn Radii: Defined in Chapter 1310.

Intersections/Ramp Terminals: Intersection Sight Distance: Defined in Chapter 1310, Intersections at Grade, and Chapter 1360, Interchanges.

Barriers: Terminals and Transition Sections:

- Terminals: Crashworthy end treatments for longitudinal barriers that are designed to reduce the potential for spearing, vaulting, rolling, or excessive deceleration of impacting vehicles from either direction of travel. Impact attenuators are considered terminals. Beam guardrail terminals include anchorage.
- Transition Sections: Sections of barriers used to produce a gradual stiffening of a flexible or semirigid barrier as it connects to a more rigid barrier or fixed object (see Chapters 1600, 1610, and 1620).

Barriers: Standard Run: Guardrail and other barriers as shown in the *Standard Plans for Road Bridge and Municipal Construction,* excluding terminals, transitions, attenuators, and bridge rails (see Chapter 1610).

Barriers: Bridge Rail: Barrier on a bridge, excluding transitions (see Chapter 1610).

(3) Design Level

In the non-Interstate matrices, design levels are noted in the cells by B, M, F, and sometimes with a number corresponding to a footnote on the matrix. For Improvement projects, full design level applies to all design elements except as noted in the design matrices and in other chapters as applicable. In the Interstate matrices, only full design level applies.

The design levels of basic, modified, and full (B, M, and F) were used to develop the design matrices. Each design level is based on the investment intended for the highway system and Project Type. (For example, the investment is greater for an Interstate overlay than for an overlay on a non-NHS route.)

(a) **Blank Cell**

A blank cell in a design matrix row signifies that the design element will not be addressed because it is beyond the scope of the typical project. In rare instances, a design element with a blank cell may be included if that element is linked to the original need that generated the project and is identified in the Project Summary or a Project Change Request Form.

(b) **Basic Design Level (B)**

Basic design level preserves pavement structures, extends pavement service life, and maintains safe highway operations. (See Chapter 1120 for design guidance.)

(c) **Modified Design Level (M)**

Modified design level preserves and improves existing roadway geometrics, safety, and operational elements. (See Chapter 1130 for design guidance.) Use full design level for design elements or portions of design elements that are not covered in Chapter 1130.

(d) **Full Design Level (F)**

Full design level improves roadway geometrics, safety, and operational elements. (See Chapter 1140 and other applicable *Design Manual* chapters for design guidance.)

⇩ Project Type	Main Line															Bridges			Barriers		
Design Elements ⇨	**Horizontal Alignment**	**Vertical Alignment**	**Lane Width**	**Shoulder Width [13]**	**On / Off Connection**	**Median Width**	**Cross Slope Lane**	**Cross Slope Shoulder**	**Fill / Ditch Slopes**	**Clear Zone**	**Signing [10]**	**Delineation [9]**	**Illumination & ITS**	**Vertical Clear. [11]**	**Bike and Pedestrian**	**Lane Width**	**Shoulder Width**	**Structural Capacity**	**Term. & Trans. Section [12]**	**Standard Run**	**Bridge Rail [14] [19]**
(1-1) Preventative Maintenance																					
Pavement Restoration																					
(1-2) Diamond Grinding										EU	EU	F		DE					F	EU	F
(1-3) Milling with HMA Inlays									EU	F	EU	F		DE					F	EU	F
(1-4) Nonstructural Overlay				DE			EU	EU	EU	F	EU	F		EU					F	F	F
Pavement Rehab. / Resurf.																					
(1-5) HMA Structural Overlays	EU	DE	F	F	F[17]	DE	F	EU	F	F	EU	F	F	F		F	DE		F	F	F
(1-6) PCCP Overlays	EU	DE	F	F	F[17]	DE	F	EU	F	F	EU	F	F	F		F	DE		F	F	F
(1-7) Dowel Bar Retrofit	EU	DE	F	F	F[17]	DE	DE		F	F	EU	F	F	DE			DE		F	F	F
Bridge Rehabilitation																					
(1-8) Bridge Deck Rehabilitation												F		F		F	DE	[11]	F[6]	F[22]	F
Safety																					
(1-9) Median Barrier				DE															F[20]	F[20]	
(1-10) Guardrail Upgrades				DE						F									F	F[23]	
(1-11) Bridge Rail Upgrades																			F	F[22]	F
(1-12) Collision Analysis Locations	Design Elements determined based on a project analysis[27]																				
Reconstruction[16]																					
(1-13) New / Reconstruction	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F

Design Matrix 1: Interstate Routes (Main Line)
Exhibit 1100-4

⇩ Project Type	Ramps and Collector Distributors																				Crossroad										
															Ramp Terminals			Barriers											Barriers		
Design Elements ⇨	Horizontal Alignment	Vertical Alignment	Lane Width	Shoulder Width	Lane Transition	On / Off Connection	Cross Slope Lane	Cross Slope Shoulder	Fill / Ditch Slopes	Limited Access	Clear Zone	Sign., Delin., Illum., & ITS [9] [10]	Vertical Clear. [11]	Bike and Pedestrian	Turn Radii	Angle	I/S Sight Distance	Term. & Trans. Section [12]	Standard Run	Bridge Rail [14] [19]	Lane Width	Shoulder Width	Fill / Ditch Slopes	Limited Access	Clear Zone	Sign., Delin., Illum., & ITS [10]	Vertical Clear. [11]	Bike and Pedestrian	Term. & Trans. Section [12]	Standard Run	Bridge Rail [14] [19]
(2-1) Preventative Maintenance																															
Pavement Restoration																															
(2-2) Diamond Grinding											EU	F[15]						F	EU	F					EU	F[15]			F	EU	F
(2-3) Milling With HMA Inlays									EU		F	F[15]	F	M				F	F	F			EU		F	F[15]		M	F	F	F
(2-4) Nonstructural Overlay							EU	EU	EU		F	F[15]	F	M				F	F	F			EU		F	F[15]		M	F	F	F
Pavement Rehab. / Resurf.																															
(2-5) HMA Structural Overlays	EU	DE	F	F	F	F[17]	F	EU	F	F	F	F[15]	F	M	F	F	F	F	F	F	DE	DE	DE	F	F	F[15]	F	M	F	F	F
(2-6) PCCP Overlays	EU	DE	F	F	F	F[17]	F	EU	F	F	F	F[15]	F	M	F	F	F	F	F	F	DE	DE	DE	F	F	F[15]	F	M	F	F	F
(2-7) Dowel Bar Retrofit	DE		DE	DE	F	F[17]	DE		F	F	F	F[15]	DE		F	F	F	F	F	F				F		F[15]			F	F	F
Bridge Rehabilitation																															
(2-8) Bridge Deck Rehabilitation													F	M				F[6]	F[22]	F							F	M	F[6]	F[22]	F
Safety																															
(2-9) Intersection			F	F	F				F	F	F	F		M	F	F	F	F	F	F			F	F	F	F	F	M	F	F	F
(2-10) Guardrail Upgrades				DE							F							F	F[23]										F	F[23]	
(2-11) Bridge Rail Upgrades																		F	F[22]	F									F	F[22]	F
(2-12) Collision Analysis Locations	Design Elements determined based on a Project Analysis[27]																														
Reconstruction[16]																															
(2-13) New / Reconstruction	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F

Design Matrix 2: Interstate Interchange Areas
Exhibit 1100-5

⇩ Project Type	Main Line															Bridges[11]				Intersections			Barriers		
Design Elements ⇨	Horizontal Alignment	Vertical Alignment	Lane Width	Shoulder Width	Lane Transition	On / Off Connection	Median Width	Cross Slope Lane	Cross Slope Shoulder	Fill / Ditch Slopes	Access [3]	Clear Zone [18]	Sign., Del., Illum., & ITS	Basic Safety	Bike & Ped.	Lane Width	Shoulder Width	Vertical Clearance	Structural Capacity	Turn Radii	Angle	I/S Sight Distance	Term. & Trans. Section [12]	Standard Run	Bridge Rail [14] [19]
Preservation																									
Roadway																									
(3-1) Non-Interstate Freeway	DE/F	DE/F	DE/F	DE/F	DE/F	DE/F	DE/F	DE/F	DE/F	DE/F	DE/F		B	B		DE/F	DE/F	F					F	B	F
(3-2) HMA/PCCP/BST Overlays	DE/M	DE/M	DE/M	DE/M	DE/F	DE/F	DE/M	DE/M	DE/M	DE/M			B	B	M	DE/M	DE/M	F				B	F	B	F
(3-3) Replace HMA w/PCCP at I/S	DE/M	DE/M	EU/M	EU/M	DE/F		DE/M	EU/M	DE/M	DE/M			B	B	M	DE/M	DE/M	F				B	F	B	F
Structures																									
(3-4) Bridge Replacement	F[2]	F[2]	F[2]	F[2]	F	F[2]	F[2]	F[2]	F[2]	F[2]		F	F		F	F[2]	F[2]	F	F	F[2]	F[2]	F	F	F	F
(3-5) Bridge Deck Rehab.													B	B	M			F					F[6]	F[22]	F
Improvements[16]																									
Mobility																									
(3-6) Non-Interstate Freeway	F	F	F	F	F	F	F	F	F	F	F	F	F		F	F	F	F	F	F	F	F	F	F	F
(3-7) Urban	F[2]	F[2]	F[2]	F[2]	F	F[2]	F[2]	F[2]	F[2]	F[2]	F	F	F		F	F[2]	F[2]	F	F	F[2]	F[2]	F	F	F	F
(3-8) Rural	F[2]	F[2]	F[2]	F[2]	F	F[2]	F[2]	F[2]	F[2]	F[2]	F	F	F		F	F[2]	F[2]	F	F	F[2]	F[2]	F	F	F	F
(3-9) HOV	F[2]	F[2]	F[2]	F[2]	F	F[2]	F[2]	F[2]	F[2]	F[2]	F	F	F		F	F[2]	F[2]	F	F	F[2]	F[2]	F	F	F	F
(3-10) Bike/Ped. Connectivity	[5]	[5]	[5]	[5]	[5]			[5]	[5]	[5]	[5]	[5]	[5]		F	[5]	[5]	[5]	[5]	[5]	[5]	[5]	[5]	[5]	[5]
Safety																									
(3-11) Non-Interstate Freeway	F	F	F	F	F	F	F	F	F	F	F	F	F		F	F	F	F		F	F	F	F	F	F
(3-12) Intersection[1]			F[2]	F[2]	F					F[2]	F	F	F		M					F	F	F	F	F	F
(3-13) Corridor[1][24]	M[4]	M[4]	M[4]	M[4]	F	F[17]	M[4]	M[4]	M[4]	M[4]	F	F	F		F	M[4]	M[4]	F		M[4]	M[4]	F	F	F	F
(3-14) Median Barrier				DE/F																			F[20]	F[20]	
(3-15) Guardrail Upgrades				DE/F																			F	F[23]	
(3-16) Bridge Rail Upgrades																							F	F[22]	F
(3-17) Risk: Roadside										F	EU/F	F	F										F	F	F
(3-18) Risk: Sight Distance	F/M[21]	F/M[21]	F/M[21]	F/M[21]						F/M[21]	F[21]	F[21]	F		F	F[21]	F[21]	F[21]		F/M[21]	F/M[21]	F[21]	F	F	F
(3-19) Risk: Roadway Width			F/M[21]	F/M[21]	F[21]	F[21]	F/M[21]	F/M[21]	F/M[21]	F/M[21]	F	F	F		F	F[21]	F[21]	F[21]		F/M[21]	F/M[21]	F[21]	F	F	F
(3-20) Risk: Realignment	F[2]	F[2]	F[2]	F[2]	F	F[2]	F[2]	F[2]	F[2]	F[2]	F	F	F		F	F[2]	F[2]	F		F[2]	F[2]	F[2]	F	F	F
(3-21) Collision Analysis Locations		Design Elements determined based on a Project Analysis[27]																							
Economic Development																									
(3-22) Freight & Goods (Frost Free)[8]	F[2]	F[2]	F[2]	F[2]	F	F[2]	F[2]	F[2]	F[2]	F[2]	EU/F	F	B		EU/F[26]	DE/F	DE/F	F	F	EU/F	EU/F	EU/F	F	F	F
(3-23) Four-Lane Trunk System	F	F	F	F	F	F	F	F	F	F	F	F	F		F	F	F	F	F	F	F	F	F	F	F
(3-24) Rest Areas (New)	F	F	F	F	F	F	F	F	F	F	F	F	F		F	F	F	F		F	F	F	F	F	F
(3-25) Bridge Restrictions	F[2]	F[2]	F[2]	F[2]	F	F[2]	F[2]	F[2]	F[2]	F[2]		F	F		EU/F[26]	F[2]	F[2]	F	F	F[2]	F[2]	F	F	F	F
(3-26) Bike Routes (Shldrs)			EU/M	[7]	EU/F				EU/M	EU/M			B	B	F	EU/M	EU/M	F				B	F	B	EU/F

Design Matrix 3: Main Line NHS Routes (Except Interstate)
Exhibit 1100-6

⇩ Project Type	Ramps and Collector-Distributors																				Crossroad											
															Ramp Terminals			Barriers												Barriers		
Design Elements ⇨	Horizontal Alignment	Vertical Alignment	Lane Width	Shoulder Width	Lane Transition	On / Off Connection	Cross Slope Lane	Cross Slope Shoulder	Fill / Ditch Slopes	Access [3]	Clear Zone	Sign., Del., Illum., & ITS	Basic Safety	Bike & Ped	Turn Radii	Angle	I/S Sight Distance	Term. & Trans. Section [12]	Standard Run	Bridge Rail [14] [19]	Lane Width	Shoulder Width	Fill / Ditch Slopes	Access [3]	Clear Zone	Sign., Del., Illum., & ITS	Basic Safety	Vertical Clearance [11]	Ped. & Bike	Term. & Trans. Section [12]	Standard Run	Bridge Rail [14] [19]
Preservation																																
Roadway																																
(4-1) Non-Interstate Freeway	DE/F	DE/F	DE/F	DE/F	DE/F	DE/F	DE/F	DE/F	DE/F	DE/F		B	B	M	DE/F	DE/F	DE/F	F	B	F	DE/F	DE/F	DE/F			B	B	F	M	F	B	F
(4-2) HMA/PCCP/BST Overlay Ramps												B	B	M			B	F	B	F						B	B	F	M	F	B	F
Structures																																
(4-3) Bridge Replacement	F[2]	F[2]	F[2]	F[2]	F	F[2]	F[2]	F[2]	F[2]	F	F	F		F	F	F	F	F	F	F	F[2]	F[2]	F[2]	F	F	F		F	F	F	F	F
(4-4) Bridge Deck Rehab.												B	B	M				F[6]	F[22]	F						B	B	F	M	F[6]	F[22]	F
Improvements[16]																																
Mobility																																
(4-5) Non-Interstate Freeway	F	F	F	F	F	F	F	F	F	F	F	F		F	F	F	F	F	F	F	F	F	F	F	F	F		F	F	F	F	F
(4-6) Urban	F[2]	F[2]	F[2]	F[2]	F	F[2]	F[2]	F[2]	F[2]	F	F	F		F	F[2]	F[2]	F	F	F	F	F[2]	F[2]	F[2]	F	F	F		F	F	F	F	F
(4-7) Rural	F[2]	F[2]	F[2]	F[2]	F	F[2]	F[2]	F[2]	F[2]	F	F	F		F	F[2]	F[2]	F	F	F	F	F[2]	F[2]	F[2]	F	F	F		F	F	F	F	F
(4-8) HOV Bypass	F[2]	F[2]	F[2]	F[2]	F	F[2]	F[2]	F[2]	F[2]	F	F	F		F	F[2]	F[2]	F	F	F	F	F[2]	F[2]	F[2]	F	F	F		F	F	F	F	F
(4-9) Bike/Ped. Connectivity	[5]	[5]	[5]	[5]	[5]		[5]	[5]	[5]	[5]	[5]	[5]		F	[5]	[5]	[5]	[5]	[5]	[5]	[5]	[5]	[5]			[5]		[5]	F	[5]	[5]	[5]
Safety																																
(4-10) Non-Interstate Freeway	F	F	F	F	F	F	F	F	F	F	F	F		M	F	F	F	F	F	F	F	F	F	F	F	F		F	M	F	F	F
(4-11) At Grade[1][25]	F[2]	F[2]	F[2]	F[2]	F	F[2]	F[2]	F[2]	F[2]	F	F	F		F	F[2]	F[2]	F	F	F	F	F[2]	F[2]	F[2]	F	F	F		F	F	F	F	F
(4-12) Intersection[1]			F[2]	F[2]	F				F[2]	F	F	F		M	F	F	F	F	F]	F			F[2]	F	F	F		F	M	F	F	F
(4-13) Guardrail Upgrades				DE/F														F	F[23]											F	F[23]	
(4-14) Bridge Rail Upgrades																														F	F[22]	F
(4-15) Risk: Roadside									F	EU/F	F	F											F	EU/F	F	F				F	F	F
(4-16) Risk: Sight Distance	F/M[21]	F/M[21]	F/M[21]	F/M[21]					F/M[21]	F[21]	F[21]	F		F	F/M[21]	F/M[21]	F	F	F	F			F/M[21]	F[21]	F[21]			F[21]	F			
(4-17) Risk: Roadway Width			F/M[21]	F/M[21]	F	F[21]	F/M[21]	F/M[21]	F/M[21]	F	F	F		F	F/M[21]	F/M[21]	F	F	F	F	F/M[21]	F/M[21]	F/M[21]	F	F			F[21]	F	F	F	F
(4-18) Risk: Realignment	F[2]	F[2]	F[2]	F[2]	F	F[2]	F[2]	F[2]	F[2]	F	F	F		F	F/M[21]	F/M[21]	F	F	F	F	F[2]	F[2]	F[2]	F	F			F[21]	F	F	F	F
(4-19) Collision Analysis Locations	Design Elements determined based on a Project Analysis[27]																															
Economic Development																																
(4-20) Four-Lane Trunk System	F	F	F	F	F	F	F	F	F	F	F	F			F		F	F	F	F	F	F	F	F	F	F		F		F	F	F

Design Matrix 4: Interchange Areas, NHS (Except Interstate), and Non-NHS
Exhibit 1100-7

⇩ Project Type	Main Line														Bridges[11]				Intersections			Barriers		
Design Elements ⇨	Horizontal Alignment	Vertical Alignment	Lane Width	Shoulder Width	Lane Transition	Median Width	Cross Slope Lane	Cross Slope Shoulder	Fill / Ditch Slopes	Access [3]	Clear Zone [18]	Sign., Del., Illum., & ITS	Basic Safety	Bike & Ped.	Lane Width	Shoulder Width	Vertical Clearance	Structural Capacity	Turn Radii	Angle	I/S Sight Distance	Term. & Trans. Section [12]	Standard Run	Bridge Rail [19]
Preservation																								
Roadway																								
(5-1) HMA/PCCP												B	B	M			F				B	F	B	F
(5-2) BST																								
(5-3) BST Routes/Basic Safety												B	B								B	F	B	F
(5-4) Replace HMA w/PCCP at I/S			EU/M	EU/M		DE/M	EU/M					B	B	M			F					F	B	F
Structures																								
(5-5) Bridge Replacement	M	F	M	M	F		M	M	M		F	F		F	F[2]	F[2]	F	F	M	M	F	F	F	F
(5-6) Bridge Repl. (Multilane)	F[2]	F[2]	F[2]	F[2]	F	F[2]	F[2]	F[2]	F[2]		F	F		F	F[2]	F[2]	F	F	F[2]	F[2]	F	F	F	F
(5-7) Bridge Deck Rehab.												B	B	M								F[6]	F[22]	F
Improvements[16]																								
Mobility																								
(5-8) Urban (Multilane)	F[2]	F[2]	F[2]	F[2]	F	F[2]	F[2]	F[2]	F[2]	F	F	F		F	F[2]	F[2]	F	F	EU/F	EU/F	F	F	F	F
(5-9) Urban	M	M	M	M	F		M	M	M	F	F	F		F	M	M	F	F	EU/M	EU/M	F	F	F	F
(5-10) Rural	M	M	M	M	F	M	M	M	M	F	F	F		F	M	M	F	F	EU/M	EU/M	F	F	F	F
(5-11) HOV	M	M	M	M	F	M	M	M	M	F	F	F		F	M	M	F	F	EU/M	EU/M	F	F	F	F
(5-12) Bike/Ped. Connectivity	[5]	[5]	[5]	[5]	[5]	[5]	[5]	[5]	[5]	[5]	[5]	[5]		F	[5]	[5]	[5]	[5]	[5]	[5]	[5]	[5]	[5]	[5]
Safety																								
(5-13) Non-Interstate Freeway	F[2]	F[2]	F[2]	F[2]	F[2]	F[2]	F[2]	F[2]	F[2]	F	F	F		F	F[2]	F[2]	F		F[2]	F[2]	F	F	F	F
(5-14) Intersection[1]			M[4]	M[4]	F				M[4]	F	F	F		M					M[4]	M[4]	F	F	F	F
(5-15) Corridor[1][24]	M[4]	M[4]	M[4]	M[4]	F	M[4]	M[4]	M[4]	M[4]	F	F	F		M	M[4]	M[4]	F		M[4]	M[4]	F	F	F	F
(5-16) Median Barrier				DE/F																		F[20]	F[20]	
(5-17) Guardrail Upgrades				DE/F																		F	F[23]	
(5-18) Bridge Rail Upgrades																						F	F[22]	F
(5-19) Risk: Roadside									M[4]	EU/F	F	F										F	F	F
(5-20) Risk: Sight Distance	F/M[21]	F/M[21]	F/M[21]	F/M[21]					F/M[21]	F[21]	F[21]	F		F	F[21]	F[21]	F[21]		F/M[21]	F/M[21]	F[21]	F	F	F
(5-21) Risk: Roadway Width			F/M[21]	F/M[21]	F	F/M[21]	F/M[21]	F/M[21]	F/M[21]	F	F	F		F	F[21]	F[21]	F[21]		F/M[21]	F/M[21]	F[21]	F	F	F
(5-22) Risk: Realignment	F/M	F/M	F/M	F/M	F	F/M	F[2]	F[2]	F/M	F	F	F		F	F[21]	F[21]	F[21]		F/M[21]	F/M[21]	F[21]	F	F	F
(5-23) Collision Analysis Locations		Design Elements determined based on a Project Analysis[27]																						
Economic Development																								
(5-24) Freight & Goods (Frost Free)[8]	EU/M	EU/M	EU/M	EU/M	EU/M	EU/M	M	M	EU/M		F	B	B	EU/F[26]	DE/M	DE/M	F		EU/M	EU/M	EU/F	F	B	F
(5-25) Rest Areas (New)	F	F	F	F	F	F	F	F	F	F	F	F		F	F	F			F	F	F	F	F	F
(5-26) Bridge Restrictions	M	F	M	M	F	M	M	M	M		F	F		EU/F[26]	M	M	F	F	M	M	F	F	F	F
(5-27) Bike Routes (Shldrs)			EU/M	[7]	EU/F			EU/M	EU/M			B	B	F	EU/M	EU/M					B	F	B	EU/F

Design Matrix 5: Main Line Non-NHS Routes
Exhibit 1100-8

Design Matrix Notes:

☐ A blank cell indicates that the element is not applicable.
F Full design level (see Chapter 1140).
M Modified design level (see Chapter 1130).
DE Design Exception to full design level.
EU Evaluate Upgrade to full design level.

[1] Collision Reduction or Collision Prevention (At-Grade Removal, Signalization & Channelization). Specific deficiencies that created the project must be upgraded to design level as stated in the matrix.

[2] Modified design level may apply based on a corridor or project analysis (see 1100.03(6)).

[3] If designated as L/A acquired in the Access Control Tracking System, limited access requirements apply. If not, managed access applies (see 1100.03(6)).

[4] Full design level may apply based on a corridor or project analysis (see 1100.03(6)).

[5] For bike/pedestrian design, see Chapters 1510, 1515, and 1520.

[6] Applies only to bridge end terminals and transition sections.

[7] 4-ft minimum shoulders.

[8] If all-weather structure can be achieved with spot digouts and overlay, modified design level applies to NHS highways and basic design level applies to non-NHS highways.

[9] Continuous shoulder rumble strips required in rural areas (see Chapter 1600).

[10] See Chapter 1020.

[11] See Chapter 720.

[12] Impact attenuators are considered as terminals.

[13] See Chapters 1140 and 1230.

[14] Includes crossroad bridge rail (see Chapter 1610).

[15] EU for signing and illumination.

[16] For design elements not in the matrix headings, apply full design level as found in the applicable chapters and see 1100.03(2).

[17] DE for existing acceleration/deceleration lanes when length meets posted freeway speed and no significant crash history (see Chapter 1360).

[18] On managed access highways within the limits of incorporated cities and towns, city and county design standards apply to areas outside the curb or outside the paved shoulder where no curb exists.

[19] The funding sources for bridge rail are a function of the length of the bridge. Consult programming personnel.

[20] Applies to median elements only.

[21] Analyses required (see 1100.03(6) for details).

[22] Upgrade barrier, if necessary, within 200 ft of the end of the bridge.

[23] See description of Guardrail Upgrades Project Type, 1100.03(1), regarding length of need.

[24] Apply full design level to projects that realign or reconstruct significant portions of the alignment.

[25] For main line, use the Project Type row for Safety, Non-Interstate Freeway on Matrix 3 for NHS and on Matrix 5 for non-NHS.

[26] Sidewalk ramps must be addressed for ADA compliance (see Chapter 1510).

[27] Collision Analysis Locations (CALs) require a project analysis to document the needs at a location and determine the appropriate design elements to address.

Design Matrix Notes
Exhibit 1100-9

Chapter 1120 Basic Design Level

1120.01 General

Basic design level (B) preserves pavement structures, extends pavement service life, and restores the roadway for reasonably safe operations, which may include safety enhancements. Flexibility is provided so that other enhancements may be made while remaining within the scope of pavement preservation work.

The basic safety items of work listed below may be programmed under a separate project from the paving project as long as:

- There is some benefit to the delay.
- The safety features remain functional.
- The work is completed within two years after the completion of the paving project.

If some of the items are separated from the paving project, maintain a separate documentation file that addresses the separation of work during the two year time period.

For bituminous surface treatment projects on non-NHS routes, the separation of basic safety is not limited to the two-year time period. The basic safety work can be accomplished separately using a corridor-by-corridor approach.

1120.02 Basic Safety

For basic design level, include the following items of work:

- Install and replace delineation in accordance with Chapter 1030.
- Install and replace rumble strips in accordance with the design matrices (see Chapters 1100 and 1600).
- Adjust existing features (such as monuments, catch basins, and access covers) that are affected by resurfacing.
- Adjust guardrail height in accordance with Chapter 1610.
- Replace signing as needed; this does not include replacement of sign bridges or cantilever supports.
- Relocate, protect, or provide breakaway features for sign supports, luminaires, WSDOT electrical service poles, and other intelligent transportation systems (ITS) equipment inside the Design Clear Zone. Consult with the region Traffic Engineer and review the WSDOT ITS plan to determine the specific ITS devices within the project limits and the requirements for each project (see Chapters 1020, 1040, 1050, and 1330).

- Restore sight distance at public road intersections and the inside of curves through low-cost measures (when available) such as removal or relocation of signs and other obstructions or cutting of vegetative matter.
- Upgrade bridge rail in accordance with the matrices and Chapter 1610.
- Upgrade barrier terminals and bridge end protection, including transitions, in accordance with Chapter 1610.
- Restore the cross slope to 1.5% when the existing cross slope is flatter than 1.5% and the steeper slope is needed to provide adequate highway runoff in areas of intense rainfall.
- Remove the rigid top rail and brace rails from Type 1 and Type 6 chain link fence and retrofit with a tension wire design (see Chapter 560).

1120.03 Minor Safety and Minor Preservation Work

Consider the following items, where appropriate, within the limits of a pavement Preservation project:

- Spot safety enhancements, which are modifications to isolated roadway or roadside features that, in the engineer's judgment, reduce potential accident frequency or severity.
- When recommended by the region Traffic Engineer, additional or improved channelization to address intersection-related accident concerns, where sufficient pavement width and structural adequacy exist or can be obtained. With justification, which considers the impacts to all roadway users, channelization improvements may be implemented, with lane and shoulder widths no less than the design criteria specified in the "Rechannelize Existing Pavement projects" section in Chapter 1110. Consider illumination of these improvements. Document decisions when full illumination is not provided, including an analysis of the frequency and severity of nighttime accidents.
- Roadside safety hardware (such as guardrail, signposts, and impact attenuators).
- Addressing Location 1 Utility Objects in accordance with the *Utilities Accommodation Policy*.
- Consider the addition of traffic signal control, illumination, and intelligent transportation systems (ITS) equipment. Consult with the region Traffic Engineer and review the WSDOT ITS plan to determine the specific requirements for each project (see Chapters 1040, 1050, and 1330).

To maintain the intended function of existing systems, consider the following:

- Right of way fencing (see Chapter 560)
- Drainage (see Chapter 800)
- Illumination (see Chapter 1040)
- Intelligent transportation systems (ITS) (see Chapter 1050)
- Traffic control signals (see Chapter 1330)
- Pedestrian use (see Chapters 1510 and 1515)

- Bicycle use (see Chapters 1515 and 1520)

Examples of the above include, but are not limited to:

- Installing short sections of fence needed to control access.
- Replacing grates that are not bicycle-safe (see Chapter 1520).
- Upgrading electrical system components that require excessive maintenance.
- Replacing or upgrading a traffic signal controller.
- Installing conduit and junction boxes for future traffic signal control, illumination, or ITS projects.
- Replacing or upgrading nonstructural traffic control signals, illumination, and ITS equipment that is near or beyond the life expectancy.
- Beveling culverts.

1120.04 Documentation

For the list of documents required to be preserved in the Design Documentation Package and the Project File, see the Design Documentation Checklist:
www.wsdot.wa.gov/design/projectdev/

1140.12 Parking

In urban design areas and rural communities, land use might make parking along the highway desirable. In general, on-street parking decreases capacity, increases accidents, and impedes traffic flow; therefore, it is desirable to prohibit parking.

Although design data for parking lanes are included in Exhibits 1140-6 through 1140-9, consider them only in cooperation with the municipality involved. The lane widths given are the minimum for parking; provide wider widths when feasible.

Angle parking is not permitted on any state route without WSDOT approval (RCW 46.61.575). This approval is delegated to the State Traffic Engineer. Angle parking approval is to be requested through the Headquarters (HQ) Design Office. Provide an engineering study, approved by the region Traffic Engineer, with the request documenting that the parking will not unduly reduce safety and that the roadway is of sufficient width that parking will not interfere with the normal movement of traffic.

1140.13 Pavement Type

The pavement types given in Exhibits 1140-5 through 1140-8 are those recommended for each design class. (See Chapter 620 for information on pavement type selection.) When a roadway is to be widened and the existing pavement will remain, the new pavement type may be the same as the existing without a pavement type determination.

1140.14 Structure Width

Provide a clear width between curbs or barrier on a structure not less than the approach roadway width (lanes plus shoulders). The structure widths given in Exhibits 1140-5 through 1140-9 are the minimum structure widths for each design class.

Additional width for shy to barriers is not normally added to the roadway width on structures. When a structure is in a run of roadside barrier with the added width, consider adding the width on shorter structures to keep a constant roadway width.

1140.15 Right of Way Width

Provide right of way width sufficient to accommodate roadway elements and appurtenances for the current design and known future improvements. To allow for construction and maintenance activities, provide 10 feet desirable, 5 feet minimum, wider than the slope stake for fill and slope treatment for cut. For slope treatment information, see Chapter 1230 and the *Standard Plans*.

The right of way widths given in Exhibits 1140-5 through 1140-8 are desirable minimums for new alignment requiring purchase of new right of way. For additional information on right of way acquisition, see Chapter 510.

1140.16 Grades

Grades can have a pronounced effect on the operating characteristics of the vehicles negotiating them. Generally, passenger cars can readily negotiate grades as steep as 5% without appreciable loss of speed from that maintained on level highways. Trucks, however, travel at the average speed of passenger cars on the level roadway, but they display up to a 5% increase in speed on downgrades and a 7% or greater decrease in speed on upgrades (depending on length and steepness of grade as well as weight-to-horsepower ratio).

The maximum grades for the various functional classes and terrain conditions are shown in Exhibits 1140-5 through 1140-8. For the effects of these grades on the design of a roadway, see Chapters 1220, 1260, 1270, 1310, and 1360.

1140.17 Fencing

Remove rigid top rails and brace rails from existing fencing and retrofit with a tension wire design. For information on fencing, see Chapter 560.

1140.18 Traffic Signal Control, Illumination, and Intelligent Transportation Systems (ITS)

For information on intelligent transportation systems (ITS), see Chapter 1050. ITS installation is determined by the mobility, traveler information, safety, maintenance, and other operational needs of the highway system. Consult with the region Traffic Engineer and review the WSDOT ITS plan to determine the full design level requirements for ITS: 🖰 wwwi.wsdot.wa.gov/MaintOps/traffic/pdf/ITSPlan32409.pdf

1140.<u>19</u> Documentation

For the list of documents required to be preserved in the Design Documentation Package and the Project File, see the Design Documentation Checklist:
🖰 www.wsdot.wa.gov/design/projectdev/

Principal Arterial Notes:

[1] Justify the selection of a P-6 design class on limited access highways.

[2] The design year is 20 years after the year the construction is scheduled to begin.

[3] When considering a multilane highway, perform an investigation to determine whether a truck-climbing lane or passing lane will satisfy the need (see Chapter 1270).

[4] Where DHV exceeds 700, consider 4 lanes. When the volume/capacity ratio is equal to or exceeds 0.75, consider the needs for a future 4-lane facility. When considering truck-climbing lanes on a P-3 design class highway, perform an investigation to determine whether a P-2 design class highway is justified.

[5] For access control, see Chapters 530 and 540 and the Limited Access and Managed Access Master Plan. Contact the HQ Design Office Access & Hearings Unit for additional information.

[6] Full or modified access control may also be used.

[7] Contact the Rail Office of the Public Transportation and Rail Division for input on railroad needs.

[8] Separate main line and major spur railroad tracks. Consider allowing at-grade crossings at minor spur railroad tracks.

[9] Criteria for railroad grade separations are not clearly definable. Evaluate each site regarding the risk. Provide justification for railroad grade separations.

[10] For existing roadways, see 1140.07.

[11] These are the design speeds for level and rolling terrain in rural design areas. They are the desirable design speeds for mountainous terrain and urban design areas. Higher design speeds may be selected, with justification.

[12] These design speeds may be selected in mountainous terrain, with a corridor analysis. Do not select a design speed that is less than the posted speed.

[13] In urbanized areas, with a corridor analysis, 50 mph may be used as the minimum design speed. Do not select a design speed that is less than the posted speed.

[14] In urban design areas, with a corridor analysis, these values may be used as the minimum design speed. Do not select a design speed that is less than the posted speed.

[15] Provide 12-ft lanes when the truck DDHV is 150 or greater.

[16] When guardrail is installed along existing shoulders with a width greater than 4 ft, the shoulder width may be reduced by 4 inches.

[17] 12-ft shoulders are desirable when the truck DDHV is 250 or greater.

[18] When curb section is used, the minimum shoulder width from the edge of traveled way to the face of curb is 4 ft.

[19] Minimum left shoulder width is to be as follows: 4 lanes – 4 ft; 6 or more lanes – 10 ft. Consider 12-ft shoulders on facilities with 6 or more lanes and a truck DDHV of 250 or greater.

[20] For existing 6-lane roadways, an existing 6-ft left shoulder is a design exception when the shoulder is not being reconstructed and no other widening will be provided.

[21] Restrict parking when DHV is over 1500.

[22] For pavement type determination, see Chapter 620.

[23] Desirable width. Provide right of way width 10 ft desirable, 5 ft minimum, wider than the slope stake for fill and slope treatment for cut (see 1140.15).

[24] 63 ft from edge of traveled way.

[25] Make right of way widths not less than those for cross section elements.

[26] For the minimum vertical clearance, see Chapter 720.

[27] For median widths 26 ft or less, address bridges in accordance with Chapter 720.

[28] For bicycle guidelines, see Chapter <u>1520</u>. For pedestrian and sidewalk guidelines, see Chapter <u>1510</u>. <u>For shared-use path design, see Chapter 1515.</u> Curb guidelines are in 1140.11. Lateral clearances from the face of curb to obstruction are in Chapter 1600.

[29] For grades at design speeds greater than 60 mph in urban design areas, use rural criteria.

[30] Grades 1% steeper may be used in urban design areas and mountainous terrain with critical right of way controls.

[31] Consider 10-ft shoulders when truck DHV is 250 or greater.

[32] Consider 10-ft shoulders when truck DDHV is 250 or greater.

[33] Consider 40 ft for shorter structures.

Geometric Design Data: Principal Arterial
Exhibit 1140-6 (continued)

Design Class		Divided Multilane		Two-Lane						Undivided Multilane	
		M-1		M-2		M-3		M-4		M-5[1]	
		Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
DHV in Design Year[2]	NHS	Over 700[3]		Over 201[4]		61–200		60 and Under		Over 700[3]	
	Non-NHS			Over 401		201–400		200 and Under			
Access Control[5]		Partial[6]									
Separate Cross Traffic											
Highways		Where Justified		Where Justified		Where Justified		Where Justified		Where Justified	
Railroads[7]		All		All[8]		Where Justified[9]		Where Justified[9]		Where Justified[9]	
Design Speed (mph)[10]											
Desirable[11]		70		70	60	70	60	60	60	70	60
Minimum[12][13]		50		50	40	50	40	40	30	40	30
Traffic Lanes											
Number		4 or 6 divided		2		2		2		4	4 or 6
Width (ft)		12		12		12		12		12	11[14]
Shoulder Width (ft)[15]											
Right of Traffic		10		8[30]		6		4		8[31]	8[16]
Left of Traffic		Variable[17][18]									
Median Width (ft)		[19]								[19]	
Parking Lanes Width (ft) – Minimum		None		None		None	10	None	10	None	10[20]
Pavement Type[21]		High								High or Intermediate	
Right of Way Width (ft)[22]		[23]	[24]	120	80	120	80	100	80	150	80
Structures Width (ft)[25]		Full Rdwy Width[26]		40		36[32]		32		Full Rdwy Width	
Other Design Considerations–Urban				[27]		[27]		[27]		[27]	

Type of Terrain	Rural Design Speed (mph)									Urban Design Speed (mph)						
	40	45	50	55	60	65	70	75	80	30	35	40	45	50	55	60[28]
Level	5	5	4	4	3	3	3	3	3	8	7	7	6	6	5	5
Rolling	6	6	5	5	4	4	4	4	4	9	8	8	7	7	6	6
Mountainous	8	7	7	6	6	5	5	5	5	11	10	10	9	9	8	8

Grades (%)[29]

Geometric Design Data: Minor Arterial
Exhibit 1140-7

Minor Arterial Notes:

[1] Justify the selection of an M-5 design class on limited access highways.

[2] The design year is 20 years after the year the construction is scheduled to begin.

[3] When considering a multilane highway, perform an investigation to determine whether a truck-climbing lane or passing lane will satisfy the need (see Chapter 1270).

[4] Where DHV exceeds 700, consider 4 lanes. When the volume/capacity ratio is equal to or exceeds 0.75, consider the needs for a future 4-lane facility. When considering truck-climbing lanes on an M-2 design class highway, perform an investigation to determine whether an M-1 design class highway is justified.

[5] For access control, see Chapters 530 and 540 and the Limited Access and Managed Access Master Plan. Contact the Access & Hearings Section of the HQ Design Office for additional information.

[6] Full or modified access control may also be used.

[7] Contact the Rail Office of the Public Transportation and Rail Division for input on railroad needs.

[8] Separate main line and major spur railroad tracks. Consider allowing at-grade crossings at minor spur railroad tracks.

[9] Criteria for railroad grade separations are not clearly definable. Evaluate each site regarding the risk. Provide justification for railroad grade separations.

[10] For existing roadways, see 1140.07.

[11] These are the design speeds for level and rolling terrain in rural design areas. They are the desirable design speeds for mountainous terrain and urban design areas. Higher design speeds may be selected, with justification.

[12] In urban design areas, with a corridor analysis, these values may be used as the minimum design speed. Do not select a design speed that is less than the posted speed.

[13] These design speeds may be selected in mountainous terrain, with a corridor analysis. Do not select a design speed that is less than the posted speed.

[14] When the truck DDHV is 150 or greater, consider 12-ft lanes.

[15] When guardrail is installed along existing shoulders with a width greater than 4 ft, the shoulder width may be reduced by 4 inches.

[16] When curb section is used, the minimum shoulder width from the edge of traveled way to the face of curb is 4 ft.

[17] The minimum left shoulder width is 4 ft for 4 lanes and 10 ft for 6 or more lanes.

[18] For existing 6-lane roadways, an existing 6-ft left shoulder is a design exception when the shoulder is not being reconstructed and no other widening will be provided.

[19] Minimum median width is as required for shoulders and barrier (including shy distance) or ditch (see 1140.10).

[20] Restrict parking when DHV is over 1500.

[21] For pavement type determination, see Chapter 620.

[22] Desirable width. Provide right of way width 10 ft desirable, 5 ft minimum, wider than the slope stake for fill and slope treatment for cut (see 1140.15).

[23] 63 ft from edge of traveled way.

[24] Make right of way widths not less than those for cross section elements.

[25] For the minimum vertical clearance, see Chapter 720.

[26] For median widths 26 ft or less, address bridges in accordance with Chapter 720.

[27] For bicycle guidelines, see Chapter 1520. For pedestrian and sidewalk guidelines, see Chapter 1510. <u>For shared-use path guidelines, see Chapter 1515.</u> Curb guidelines are in 1140.11. Lateral clearances from the face of curb to obstruction are in Chapter 1600.

[28] For grades at design speeds greater than 60 mph in urban design areas, use rural criteria.

[29] Grades 1% steeper may be used in urban design areas and mountainous terrain with critical right of way controls.

[30] Consider 10-ft shoulders when truck DHV is 250 or greater.

[31] Consider 10-ft shoulders when truck DDHV is 250 or greater.

[32] Consider 40 ft for shorter structures.

Geometric Design Data: Minor Arterial
Exhibit 1140-7 (continued)

Design Class	Undivided Multilane		Two-Lane					
	C-1		C-2		C-3		C-4	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
DHV in Design Year[1] NHS / Non-NHS	Over 900[2]		Over 301[3] / Over 501		201–300 / 301–500		200 and Under / 300 and Under	
Access Control	[4]		[4]		[4]		[4]	
Separate Cross Traffic Highways / Railroads[5]	Where Justified / Where Justified[6]		Where Justified / All[6]		Where Justified / Where Justified[6]		Where Justified / Where Justified[6]	
Design Speed (mph)[7] Desirable[8] / Minimum[9][10]	70 / 40	60 / 30	70 / 50	60 / 40	70 / 50	60 / 40	60 / 40	60 / 30
Traffic Lanes Number / Width (ft)	4 / 12	4 or 6 / 11[11]	2 / 12		2 / 12		2 / 12	
Shoulder Width (ft)[12]	8[21]	8[13]	8[22]		6		4	
Median Width (ft)	[14]							
Parking Lane Width (ft) – Minimum	None	10	None		None	10	None	10
Pavement Type[15]	High or Intermediate							
Right of Way (ft)[16]	150	80	120	80	120	80	100	80
Structures Width (ft)[17]	Full Roadway Width		40		36[23]		32	
Other Design Considerations – Urban	[18]		[18]		[18]		[18]	

Type of Terrain	Rural Design Speed (mph)										Urban Design Speed (mph)								
	25	**30**	**35**	**40**	**45**	**50**	**55**	**60**	**65**	**70**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**[19]
Level	7	7	7	7	7	6	6	5	5	4	9	9	9	9	9	8	7	7	6
Rolling	10	9	9	8	8	7	7	6	6	5	12	12	11	10	10	9	8	8	7
Mountainous	11	10	10	10	10	9	9	8	8	6	14	13	12	12	12	11	10	10	9

Grades (%)[20]

Geometric Design Data: Collector
Exhibit 1140-8

Collector Notes:

[1] The design year is 20 years after the year the construction is scheduled to begin.

[2] When considering a multilane highway, perform an investigation to determine whether a truck-climbing lane or passing lane will satisfy the need (see Chapter 1270).

[3] Where DHV exceeds 900, consider 4 lanes. When the volume/capacity ratio is equal to or exceeds 0.85, consider the needs for a future 4-lane facility. When considering truck-climbing lanes on a C-2 design class highway, perform an investigation to determine whether a C-1 design class highway is justified.

[4] For access control, see Chapters 530 and 540 and the Limited Access and Managed Access Master Plan. Contact the Access & Hearings Section in the HQ Design Office for additional information.

[5] Contact the Rail Office of the Public Transportation and Rail Division for input on railroad needs.

[6] Criteria for railroad grade separations are not clearly definable. Evaluate each site regarding the risk. Provide justification for railroad grade separations.

[7] For existing roadways, see 1140.07.

[8] These are the design speeds for level and rolling terrain in rural design areas. They are the desirable design speeds for mountainous terrain and urban design areas. Higher design speeds may be selected, with justification. Do not select a design speed that is less than the posted speed.

[9] In urban design areas, with a corridor analysis, these values may be used as the minimum design speed. Do not select a design speed that is less than the posted speed.

[10] These design speeds may be selected in mountainous terrain, with a corridor analysis. Do not select a design speed that is less than the posted speed.

[11] Consider 12-ft lanes when the truck DDHV is 200 or greater.

[12] When guardrail is installed along existing shoulders with a width greater than 4 ft, the shoulder width may be reduced by 4 inches.

[13] When curb section is used, the minimum shoulder width from the edge of traveled way to the face of curb is 4 ft.

[14] Minimum median width is as required for shoulders and barrier (including shy distance) or ditch (see 1140.10).

[15] For pavement type determination, see Chapter 620.

[16] Desirable width. Provide right of way width 10 ft desirable, 5 ft minimum, wider than the slope stake for fill and slope treatment for cut (see 1140.15).

[17] For the minimum vertical clearance, see Chapter 720.

[18] For bicycle guidelines, see Chapter 1520. For pedestrian and sidewalk guidelines, see Chapter 1510. For shared-use path guidelines, see Chapter 1515. Curb guidelines are in 1140.11. Lateral clearances from the face of curb to obstruction are in Chapter 1600.

[19] For grades at design speeds greater than 60 mph in urban design areas, use rural criteria.

[20] Grades 1% steeper may be used in urban design areas and mountainous terrain with critical right of way controls.

[21] Consider 10-ft shoulders when truck DDHV is 250 or greater.

[22] Consider 10-ft shoulders when truck DHV is 250 or greater.

[23] Consider 40 ft for shorter structures.

Geometric Design Data: Collector
Exhibit 1140-8 (continued)

Design Class	Divided Multilane		Undivided Multilane		Two-Lane	
	$U_{M/A}$-1	$U_{M/A}$-2	$U_{M/A}$-3	$U_{M/A}$-4	$U_{M/A}$-5	$U_{M/A}$-6
DHV in Design Year[1]	Over 700	Over 700	700–2,500	Over 700	All	All
Design Speed (mph)	Greater than 45	45 or less	35 to 45	30 or less	Greater than 45	45 or less
Access	[2]	[2]	[2]	[2]	[2]	[2]
Traffic Lanes						
Number	4 or more	4 or more	4 or more	4 or more	2	2
Width (ft) NHS	12[4]	12[3]	12[3]	12[3]	12[6]	12[3]
Non-NHS	12[4]	11[5]	11[5]	11[5]	12[6]	11[7]
Shoulder Width (ft)[8]						
Right of Traffic[9]	10	10	8	8	8[10]	4
Left of Traffic	4	4				
Median Width (ft)[11]			[12]	[12]		
Parking Lane Width (ft)	None	10[13]	10[13]	8[14]	10[15]	8[14]
Structures Width (ft)[16]	Full Roadway Width[17]		Full Roadway Width		32	30
Other Design Considerations	[18]	[18]	[18]	[18]	[18]	[18]

Urban Managed Access Highways Notes:

[1] The design year is 20 years after the year the construction is scheduled to begin.

[2] The urban managed access highway design is used on managed access highways (see Chapter 540).

[3] May be reduced to 11 ft, with justification.

[4] May be reduced to 11 ft, with justification, when truck DDHV is less than 200.

[5] Consider 12-ft lanes when truck DDHV is 200 or greater.

[6] May be reduced to 11 ft, with justification, when truck DHV is less than 100.

[7] Consider 12-ft lanes when truck DHV is 100 or greater.

[8] When curb section is used, see Exhibit 1140-3.

[9] When guardrail is installed along existing shoulders with a width greater than 4 ft, the shoulder width may be reduced by 4 inches.

[10] When DHV is 200 or less, may be reduced to 4 ft.

[11] Minimum width is as required for shoulders and barrier or ditch (see 1140.10).

[12] 2 ft desirable. When a TWLTL is present, 13 ft is desirable, 11 ft is minimum.

[13] Prohibit parking when DHV is over 1500.

[14] 10 ft is desirable.

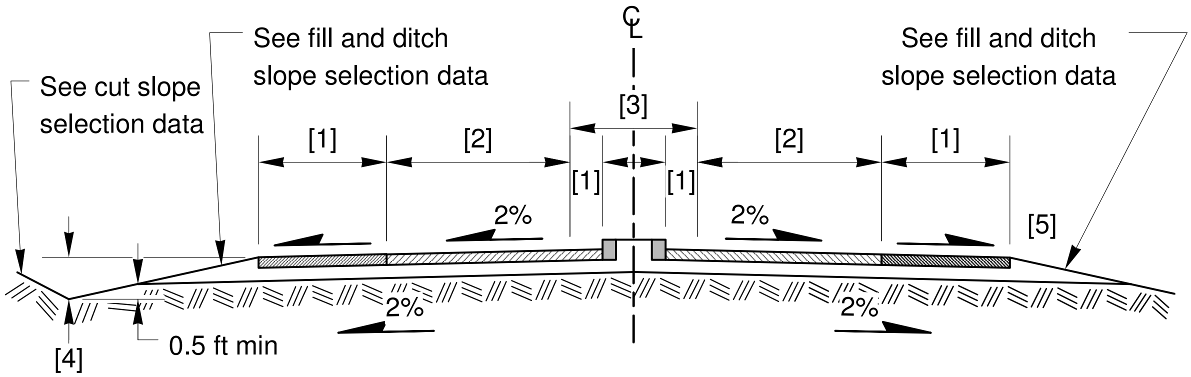
[15] Prohibit parking when DHV is over 500.

[16] For minimum vertical clearance, see Chapter 720.

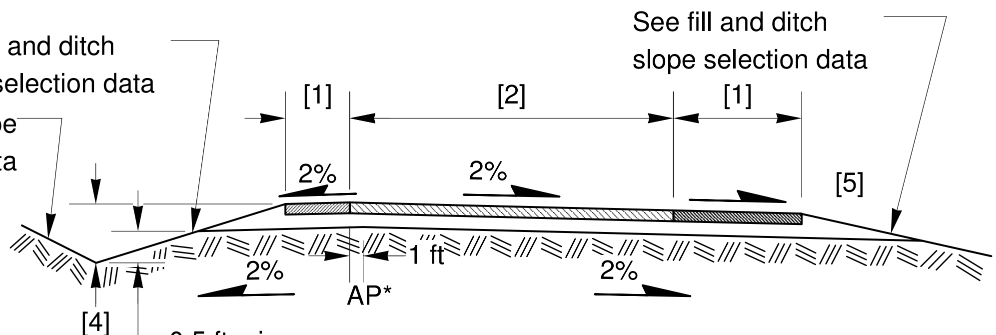
[17] For median guidelines, see Chapter 720.

[18] For bicycle guidelines, see Chapter 1520. For pedestrian and sidewalk guidelines, see Chapter 1510. For shared-use path guidelines, see Chapter 1515. Lateral clearances from face of curb to obstruction are in Chapter 1600. For railroad and other roadway grade separation, maximum grade, and pavement type for the functional class, see Exhibits 1140-6 through 1140-8. Make right of way widths not less than for cross section elements.

Geometric Design Data: Urban Managed Access Highways
Exhibit 1140-9



Two-Way Ramp

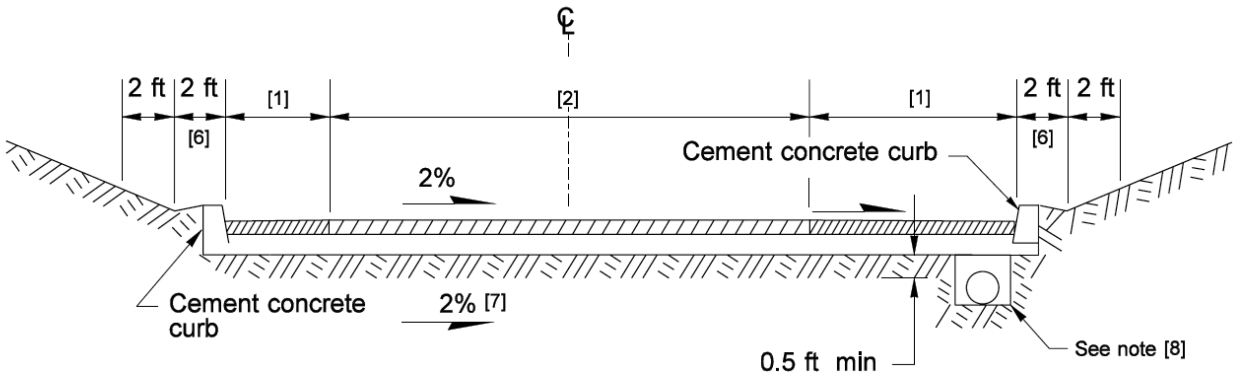


One-Way Ramp

*AP = Angle point in the subgrade

Note:
For applicable notes, dimensions, and slope selection tables, see Exhibit 1230-4b.

Ramp Roadway Sections
Exhibit 1230-4a



Special Design

This special design section may be used when restrictions (high right of way costs or physical features) make construction difficult or costly.

Height of fill/depth of ditch (ft)	Slope not steeper than[9]
0 – 10	6H:1V
10 – 20	4H:1V
20 – 30	3H:1V[5]
over 30	2H:1V[5][11]

Fill and Ditch Slope Selection

Height of cut (ft)*	Slope not steeper than
0 – 5	6H:1V
5 – 20	3H:1V
over 20	2H:1V[10]
*From bottom of ditch	

Cut Slope Selection[12]

Notes:

[1] For shoulder details, see Exhibits 1230-5a and 5b. For minimum shoulder widths, see Chapter 1360.
[2] For minimum ramp lane widths, see Chapter 1360. For turning roadway width, see Chapter 1240. For two-way ramps, treat each direction as a separate one-way roadway.
[3] See Chapter 1360 for the minimum median width of a two-way ramp.
[4] Minimum ditch depth is 2 feet for design speeds over 40 mph and 1.5 feet for design speeds of 40 mph or less. Rounding may be varied to fit drainage requirements when minimum ditch depth is 2 feet.
[5] Widen and round foreslopes steeper than 4H:1V, as shown in Exhibit 1230-5b.
[6] 2-foot widening and rounding may be omitted when slopes are 4H:1V or flatter.
[7] Subgrade may slope to the left if the left edge is in embankment.
[8] Provide drainage unless one edge of the roadway is in embankment or subject material is free draining. Method of drainage pickup is to be determined by the designer.
[9] Where practicable, consider flatter slopes for the greater fill heights and ditch depths.
[10] Cut slopes steeper than 2H:1V may be used where favorable soil conditions exist or stepped construction is used. (See Chapter 1600 for clear zone and barrier guidelines.)
[11] Fill slopes as steep as 1½H:1V may be used where favorable soil conditions exist. (See Chapter 1600 for clear zone and barrier guidelines.)
[12] The values in the Cut Slope Selection table are desirable. Provide justification for the use of steeper slopes unless the geotechnical report identifies a specific need and recommends them. Do not disturb existing stable slopes just to meet the slope guidelines given in this table.

Ramp Roadway Sections
Exhibit 1230-4b

Chapter 1260 Sight Distance

1260.01 General

The driver of a vehicle needs to see far enough ahead to assess developing situations and take actions appropriate for the conditions. For the purposes of design, sight distance is considered in terms of stopping sight distance, passing sight distance, and decision sight distance.

For additional information, see the following chapters:

Chapter	Subject
1250	Sight distance at railroad crossings
1310	Sight distance at intersections at grade
1320	Sight distance at roundabouts
1340	Sight distance at road approaches
1515	Sight distance for shared-use paths

1260.02 References

(1) Design Guidance

Manual on Uniform Traffic Control Devices for Streets and Highways, USDOT, FHWA; as adopted and modified by Chapter 468-95 WAC “Manual on uniform traffic control devices for streets and highways” (MUTCD)

(2) Supporting Information

A Policy on Geometric Design of Highways and Streets (Green Book), AASHTO, 2004

1260.03 Definitions

Note: For definitions of ***design speed***, ***roadway***, ***rural design area***, ***suburban area***, and ***urban design area***, see Chapter 1140.

decision sight distance The distance needed for a driver to detect an unexpected or difficult-to-perceive condition, recognize the condition, select an appropriate maneuver, and complete the maneuver based on design conditions and design speed.

passing sight distance The distance (on a two-lane highway) needed for a vehicle driver to execute a normal passing maneuver based on design conditions and design speed.

sight distance The length of highway visible to a driver.

stopping sight distance The distance needed for a driver to stop a vehicle traveling at design speed based on design conditions.

1260.04 Stopping Sight Distance

(1) Design Criteria

Stopping sight distance is provided when the sight distance available to a driver equals or exceeds the stopping distance for a passenger car traveling at the design speed. Stopping distance for design is conservatively calculated, with lower deceleration and slower perception reaction time than normally expected. Note: Provide design stopping sight distance at all points on all highways and on all intersecting roadways.

(a) **Stopping Distance**

Stopping distance is the sum of two distances: the distance traveled during perception and reaction time and the distance to stop the vehicle. The perception and reaction distance used in design is the distance traveled in 2.5 seconds at the design speed. The design stopping distance is calculated using the design speed and a constant deceleration rate of 11.2 feet/second^2. (For stopping distances on grades less than 3%, see Exhibit 1260-1; for grades 3% or greater, see Exhibit 1260-3.)

(b) **Sight Distance**

Sight distance for stopping is calculated for a passenger car using an eye height (h_1) of 3.50 feet and an object height (h_2) of 0.50 foot. The object height is the height of the largest object invisible to the driver at the stopping distance. In urban design areas, with justification, the object height (h_2) may be increased to 2.00 feet. Also, the 2.00-foot object height (h_2) is used when the sightline obstruction is barrier.

(c) **Design Stopping Sight Distance**

Exhibit 1260-1 gives the design stopping sight distances for grades less than 3%, the minimum curve length for a 1% grade change to provide the sight distance (using h_2=0.50 feet) for a crest (K_c) and sag (K_s) vertical curve, and the minimum length of vertical curve for the design speed (VCL_m). For sight distances when the grade is 3% or greater, see 1260.04(2).

Design Speed (mph)	Design Stopping Sight Distance (ft)	K_c	K_s	VCL_m (ft)
25	155	18	25	75
30	200	30	36	90
35	250	47	49	105
40	305	70	63	120
45	360	98	78	135
50	425	136	96	150
55	495	184	115	165
60	570	244	136	180
65	645	313	157	195
70	730	401	180	210
75	820	506	206	225
80	910	623	231	240

Design Stopping Sight Distance
Exhibit 1260-1

1310.01 General

Intersections are a critical part of Washington State Department of Transportation (WSDOT) highway design because of increased conflict potential. Traffic and driver characteristics, bicycle and pedestrian needs, physical features, and economics are considered during the design stage to develop channelization and traffic control to provide multimodal traffic flow through intersections.

This chapter provides guidance for designing intersections at grade, including at-grade ramp terminals. Refer to the following chapters for additional information:

Chapter	**Subject**
1320	Roundabouts
1330	Traffic signals
1340	Road approaches
1360	Interchanges
1510	Pedestrian design considerations

For assistance with intersection design, contact the Headquarters (HQ) Design Office.

1310.02 References

(1) Federal/State Laws and Codes

Americans with Disabilities Act of 1990 (ADA) (28 CFR Part 36, Appendix A)

Revised Code of Washington (RCW) 35.68.075, Curb ramps for persons with disabilities – Required – Standards and requirements
http://apps.leg.wa.gov/rcw/default.aspx?cite=35.68.075

Washington Administrative Code (WAC) 468-18-040, Design standards for rearranged county roads, frontage roads, access roads, intersections, ramps and crossings
http://apps.leg.wa.gov/wac/default.aspx?cite=468-18-040

WAC 468-52, Highway access management – Access control classification system and standards
http://apps.leg.wa.gov/wac/default.aspx?cite=468-52

(2) Design Guidance

Local Agency Guidelines (LAG), M 36-63, WSDOT
www.wsdot.wa.gov/publications/manuals/m36-63.htm

Manual on Uniform Traffic Control Devices for Streets and Highways, USDOT, FHWA; as adopted and modified by Chapter 468-95 WAC "Manual on uniform traffic control devices for streets and highways" (MUTCD)
www.wsdot.wa.gov/publications/manuals/mutcd.htm

Standard Plans for Road, Bridge, and Municipal Construction (Standard Plans), M 21-01, WSDOT
www.wsdot.wa.gov/publications/manuals/m21-01.htm

(3) Supporting Information

A Policy on Geometric Design of Highways and Streets (Green Book), AASHTO, 2004

Aspects of Traffic Control Devices, Highway Research Record No. 211, pp 1-18, "Volume Warrants for Left-Turn Storage Lanes at Unsignalized Grade Intersections," Harmelink, M.D.

Guidelines and Recommendations to Accommodate Older Drivers and Pedestrians, FHWA-RD-01-051, USDOT, FHWA, May 2001

Highway Capacity Manual (HCM), Special Report 209, Transportation Research Board, National Research Council

Intersection Channelization Design Guide, NCHRP 279

Roundabouts: An Informational Guide, FHWA-RD-00-067, USDOT, FHWA

1310.03 Definitions

Note: For definitions of ***design speed***, ***divided multilane***, ***expressway***, ***highway***, ***roadway***, ***rural design area***, ***suburban area***, ***traveled way***, ***undivided multilane***, and ***urban design area***, see Chapter 1140; for ***lane***, ***median***, and ***shoulder***, see Chapter 1230; and for ***decision sight distance***, ***sight distance***, and ***stopping sight distance***, see Chapter 1260.

conflict An event involving two or more road users in which the action of one user causes the other user to make an evasive maneuver to avoid a collision.

conflict point A point where traffic paths cross, merge, or diverge.

crossroad The minor roadway at an intersection. At a stop-controlled intersection, the crossroad has the stop.

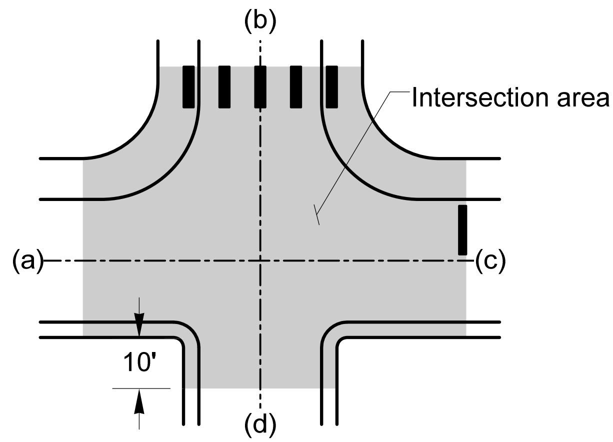
curb extensions A curb and sidewalk bulge or extension into the parking lane or shoulder to decrease the length of a pedestrian crossing (see Chapter 1510).

curb section A roadway cross section with curb and sidewalk.

design vehicle A vehicle used to establish the intersection geometry.

intersection angle The angle between any two intersecting legs at the point the centerlines intersect.

intersection area The area of the intersecting roadways bounded by the edge of traveled ways and the area of the adjacent roadways to the farthest point: (a) the end of the corner radii, (b) through any marked crosswalks adjacent to the intersection, (c) to the stop bar, or (d) 10 feet from the edge of shoulder of the intersecting roadway (see Exhibit 1310-1).



Intersection Area
Exhibit 1310-1

intersection at grade The general area where a roadway or ramp terminal is met or crossed at a common grade or elevation by another roadway.

four-leg intersection An intersection formed by two crossing roadways.

split tee A four-leg intersection with the crossroad intersecting the through roadway at two tee intersections offset by at least the width of the roadway.

tee (T) intersection An intersection formed by two roadways where one roadway terminates at the point it meets a through roadway.

wye (Y) intersection An intersection formed by three legs in the general form of a "Y" where the angle between two legs is less than 60°.

intersection leg Any one of the roadways radiating from and forming part of an intersection.

entrance leg The lanes of an intersection leg for traffic entering the intersection.

exit leg The lanes of an intersection leg for traffic leaving the intersection.

Note: Whether an intersection leg is an entrance leg or an exit leg depends on which movement is being analyzed. For two-way roadways, each leg is an entrance leg for some movements and an exit leg for other movements.

intersection sight distance The length of roadway visible to the driver of a vehicle entering an intersection.

island A defined area within an intersection, between traffic lanes, for the separation of vehicle movements or for pedestrian refuge.

roundabout A circular intersection at grade (see Chapter 1320).

rural intersection An intersection in a rural design area (see Chapter 1140).

slip ramp A connection between legs of an intersection that allows right-turning vehicles to bypass the intersection or a connection between an expressway and a parallel frontage road. These are often separated by an island.

two-way left-turn lane (TWLTL) A lane located between opposing lanes of traffic to be used by vehicles making left turns from either direction, from or onto the roadway.

urban intersection An intersection in an urban design area (see Chapter 1140).

1310.04 Intersection Configurations

At-grade intersection configurations in their simplest forms are three-leg, four-leg, and multileg. More complex designs are variations or combinations selected to accommodate the constraints and traffic presented by the location. Intersection configurations are determined by the number of intersecting legs; the topography; the character of the intersecting roadways; the traffic volumes, patterns, and speeds; and the desired type of operation.

(1) Roundabouts

Modern roundabouts are circular intersections. When well designed, they are an efficient form of intersection control. They have fewer conflict points, lower speeds, easier decision making, and need less maintenance.

When properly designed and located, roundabouts have been found to reduce injury accidents, traffic delays, fuel consumption, and air pollution. They also permit U-turns.

Include roundabouts as an alternative at intersections where:

- Stop signs result in unacceptable delays for the crossroad traffic.
- There is a high left-turn percentage.
- There are more than four legs.
- A disproportionately high number of accidents involve crossing or turning traffic.
- The major traffic movement makes a turn.
- Traffic growth is expected to be high and future traffic patterns are uncertain.
- It is not desirable to give priority to either roadway.

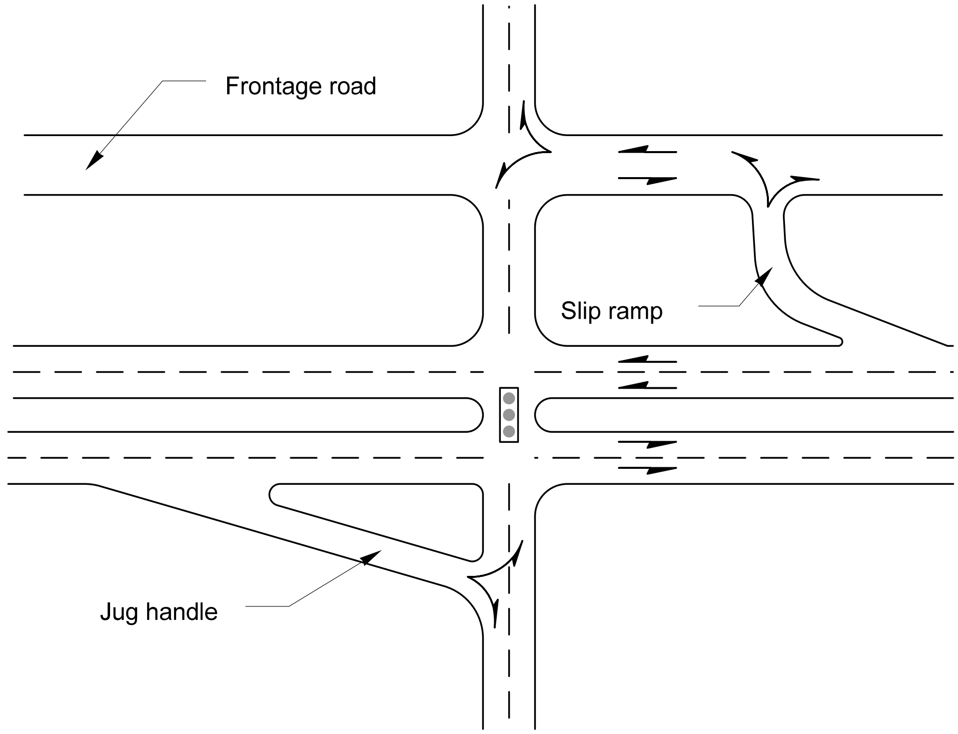
Other tradeoffs with roundabouts include:

- Roundabouts give equal priority to all legs.
- The design forces the entering traffic to reduce speed.

Refer to Chapter 1320 for information and criteria for the design and documentation of roundabouts.

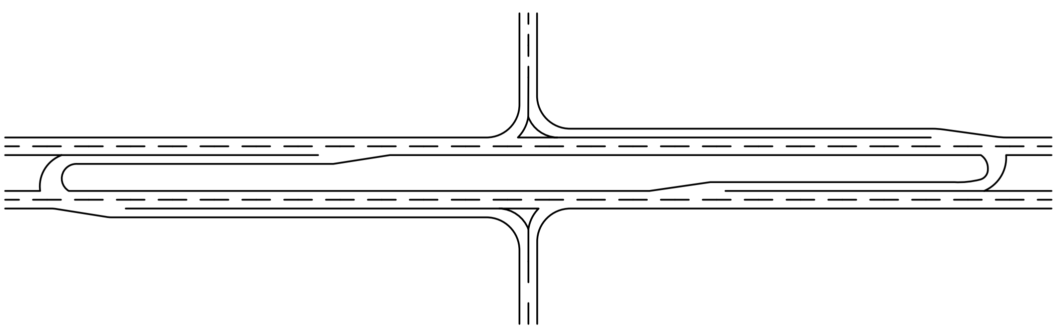
(2) Indirect Left Turns

At signalized intersections, indirect left-turn intersections reduce conflict points and delays to the major route by eliminating the left-turn phase (see Exhibit 1310-2a for an example).



Indirect Left Turns: Signalized Intersections
Exhibit 1310-2a

At unsignalized intersections, indirect left-turn intersections help mitigate entering-at-angle collisions. Left-turning and through traffic on the crossroad must turn right and then make a U-turn at a median crossover or a nearby intersection (see Exhibit 1310-2b for an example). Provide for weaving movements when selecting the distance between right turns and U-turns on major routes and the storage (if needed) for U-turning vehicles. This treatment eliminates conflict points while minimizing delays to the major route. (See 1310.08 for guidance on the design of U-turn locations.)

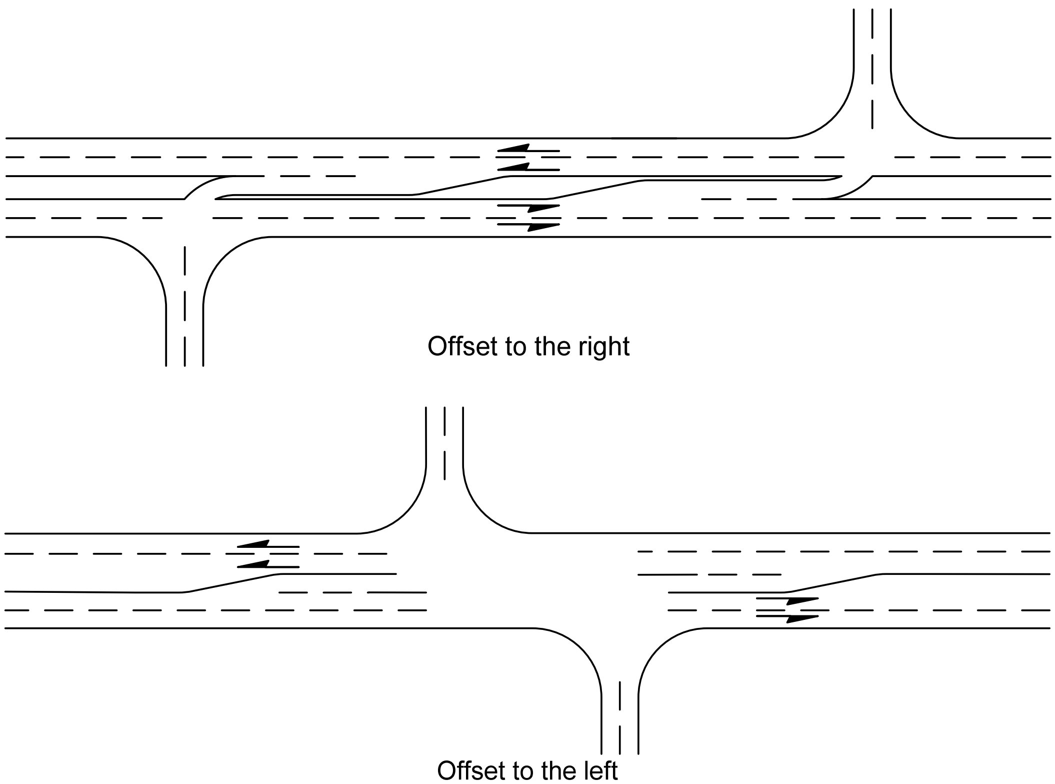


Indirect Left Turns: Unsignalized Intersections
Exhibit 1310-2b

(3) Split Tee

Avoid split tee intersections where there is less than the design intersection spacing (see 1310.05(4)). Split tee intersections with an offset distance to the left greater than the width of the roadway, but less than the intersection spacing, may be designed, with justification. Evaluate the anticipated benefits against the increased difficulty for cross traffic in driving through the intersection and a more complicated traffic signal design.

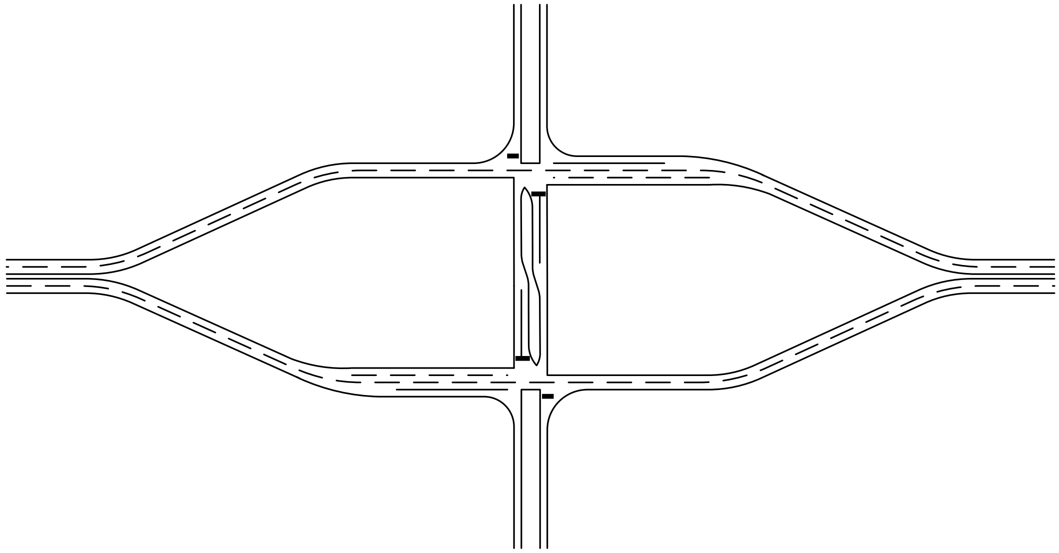
Split tee intersections with the offset to the right (see Exhibit 1310-3) have the additional disadvantages of overlapping main line left-turn lanes, the increased possibility of wrong-way movements, and a more complicated traffic signal design. Do not design a split tee intersection with an offset to the right less than the design intersection spacing (see 1310.05(4)) unless traffic is restricted to right-in/right-out only.



Split Tee Intersections
Exhibit 1310-3

(4) Split Intersections

Split intersections provide wide medians on divided multilane highways, which separate the traveled ways of the through roadway to allow storage of left-turning and crossing traffic (see Exhibit 1310-4). Traffic on the crossroad makes the through and left-turn movements in two stages, reducing the needed sight distance and the probability of the driver misjudging the gap. To avoid potential conflicts with through traffic, provide a median width sufficient to store the anticipated queue for crossing and left-turning vehicles. The minimum median width is 100 feet, with 200 to 300 feet being desirable.



Split Intersections
Exhibit 1310-4

(5) Nonstandard Configurations

Low average daily traffic (ADT) can hide operational problems. Do not design intersections with the following configurations:

- Intersections with offset legs, except for split tee intersections (see 1310.04(3)).
- Tee intersections with the major traffic movement making a turn.
- Wye intersections that are not a one-way merge or diverge.

A roundabout might be an alternative to these configurations (see 1310.04(1) and Chapter 1320).

With justification and approval from the region Traffic Engineer, existing intersections with nonstandard configurations may remain in place when an analysis shows no collision history related to the configuration.

1310.05 Design Considerations

Consider all potential users of the facility in the design of an intersection. This involves addressing the needs of a diverse mix of user groups, including passenger cars, heavy vehicles of varying classifications, bicycles, and pedestrians. Often, meeting the needs of one user group results in a compromise in service to others. Intersection design balances these competing needs, resulting in appropriate levels of operation for all users.

In addition to reducing the number of conflicts, minimize the conflict area as much as possible while still providing for the design vehicle (see 1310.06). This is done to control the speed of turning vehicles and reduce the area of exposure for vehicles, bicycles, and pedestrians. For additional information on pedestrian needs, see Chapter 1510. For intersections with shared-use paths, see Chapter 1515. For bicycle considerations at intersections, see Chapter 1520.

(1) Nongeometric Considerations

Geometric design considerations, such as sight distance and intersection angle, are important. Equally important are perception, contrast, and a driver's age. Perception is a factor in the majority of collisions. Regardless of the type of intersection, the function depends on the driver's ability to perceive what is happening with respect to the surroundings and other vehicles. When choosing an acceptable gap, the driver first identifies the approaching vehicle and then determines its speed. The driver uses visual clues provided by the immediate surroundings in making these decisions. Thus, given equal sight distance, it may be easier for the driver to judge a vehicle's oncoming speed when there are more objects to pass by in the driver's line of sight. Contrast allows drivers to discern one object from another.

(2) Intersection Angle

An important intersection design characteristic is the intersection angle. The desirable intersection angle is 90°, with 75° to 105° allowed.

Existing intersections with an intersection angle between 60° and 120° may remain. Intersection angles outside this range tend to restrict visibility; increase the area required for turning; increase the difficulty of making a turn; increase the crossing distance and time for vehicles and pedestrians; and make traffic signal arms difficult or impossible to design.

(3) Lane Alignment

Design intersections so that the entering through traffic is aligned with the exit lanes. Do not put angle points on the roadway alignments within intersection areas or on the through roadway alignment within 100 feet of the edge of traveled way of a crossroad. This includes short radius curves where both the PC and PT are within the intersection area. However, angle points within the intersection are allowed at intersections with a minor through movement, such as at a ramp terminal (see Exhibit 1310-5).

When feasible, locate intersections such that curves do not begin or end within the intersection area. It is desirable to locate the PC and PT 250 feet or more from the intersection so that a driver can settle into the curve before the gap in the striping for the intersection area.

(4) Intersection Spacing

Provide intersection spacing for efficient operation of the highway. The minimum design intersection spacing for highways with limited access control is covered in Chapter 530. For other highways, the minimum design intersection spacing is dependent on the managed access highway class. (See Chapter 540 for minimum intersection spacing on managed access highways.)

As a minimum, provide enough space between intersections for left-turn lanes and storage length. Space signalized intersections and intersections expected to be signalized to maintain efficient signal operation. Space intersections so that queues will not block an adjacent intersection.

Evaluate existing intersections that are spaced less than shown in Chapters 530 and 540. Evaluate closing or restricting movements at intersections with operational issues.

Document the spacing of existing intersections that will remain in place and the effects of the spacing on operation, capacity, and circulation.

(5) Design Vehicle

There are competing design objectives when considering the turning needs of larger vehicles and the crossing needs of pedestrians. To reduce the operational impacts of large design vehicles, larger turn radii are used. This results in increased pavement areas, longer pedestrian crossing distances, and longer traffic signal arms.

To reduce the intersection area, a smaller design vehicle is used or encroachment is allowed. This reduces the potential for vehicle/pedestrian conflicts, decreases pedestrian crossing distance, and controls the speeds of turning vehicles.

If the selected design vehicle is too small, a capacity reduction and greater speed differences between turning vehicles and through vehicles might result. If the vehicle is larger than needed, the pavement areas, pedestrian crossing distances, and traffic signal arms will also be larger than needed. (See 1310.06 for information on selecting a design vehicle and acceptable encroachments.)

(6) Sight Distance

For traffic to move through intersections, drivers need to be able to see stop signs, traffic signals, and oncoming traffic in time to react accordingly.

Provide decision sight distance in advance of stop signs, traffic signals, and roundabouts. Where decision sight distance is not feasible, with justification, stopping sight distance may be provided. (See Chapter 1260 for guidance.)

Drivers approaching an intersection on the through roadway need to be able to see the intersection far enough in advance to assess developing situations and take appropriate action. Locate new intersections where decision sight distance is available for through traffic. At crosswalks, provide decision sight distance to the area of the crosswalk and 6 feet from the edge of traveled way. Where decision sight distance is not feasible, stopping sight distance may be provided. (See Chapter 1510 for additional guidance on crosswalks and Chapter 1260 for guidance on on decision and stopping sight distances.)

The driver of a vehicle that is stopped and waiting to cross or enter a through roadway needs obstruction-free sight triangles in order to see enough of the through roadway to complete all legal maneuvers before an approaching vehicle on the through roadway can reach the intersection. (See 1310.09 for guidance on intersection sight distance sight triangles.)

(7) Crossroads

When the crossroad is a city street or county road, design the crossroad beyond the intersection area according to the applicable design criteria given in Chapter 1140.

When the crossroad is a state facility, design the crossroad according to the applicable design level and functional class (see Chapters 100, 1130, and 1140). Continue the cross slope of the through roadway shoulder as the grade for the crossroad. Use a vertical curve that is at least 60 feet long to connect to the grade of the crossroad.

Evaluate the profile of the crossroad in the intersection area. The crown slope of the main line might need to be adjusted in the intersection area to improve the profile for the cross traffic.

Design the grade at the crosswalk to meet the requirements for accessibility. (See Chapter 1510 for additional crosswalk information.)

In areas that experience accumulations of snow and ice for all legs that require traffic to stop, design a maximum grade of ±4% for a length equal to the anticipated queue length for stopped vehicles.

(8) Rural Expressway At-Grade Intersections

Evaluate grade separations at all intersections on rural expressways.

Design high-speed at-grade intersections on rural expressways as indirect left turns, split intersections, or roundabouts.

The State Traffic Engineer’s approval is required for any new intersection or signal on a rural expressway.

(9) Interchange Ramp Terminals

When stop control or traffic signal control is selected, the design to be used or modified is shown in Exhibit 1310-5. Higher-volume intersections with multiple ramp lanes are designed individually.

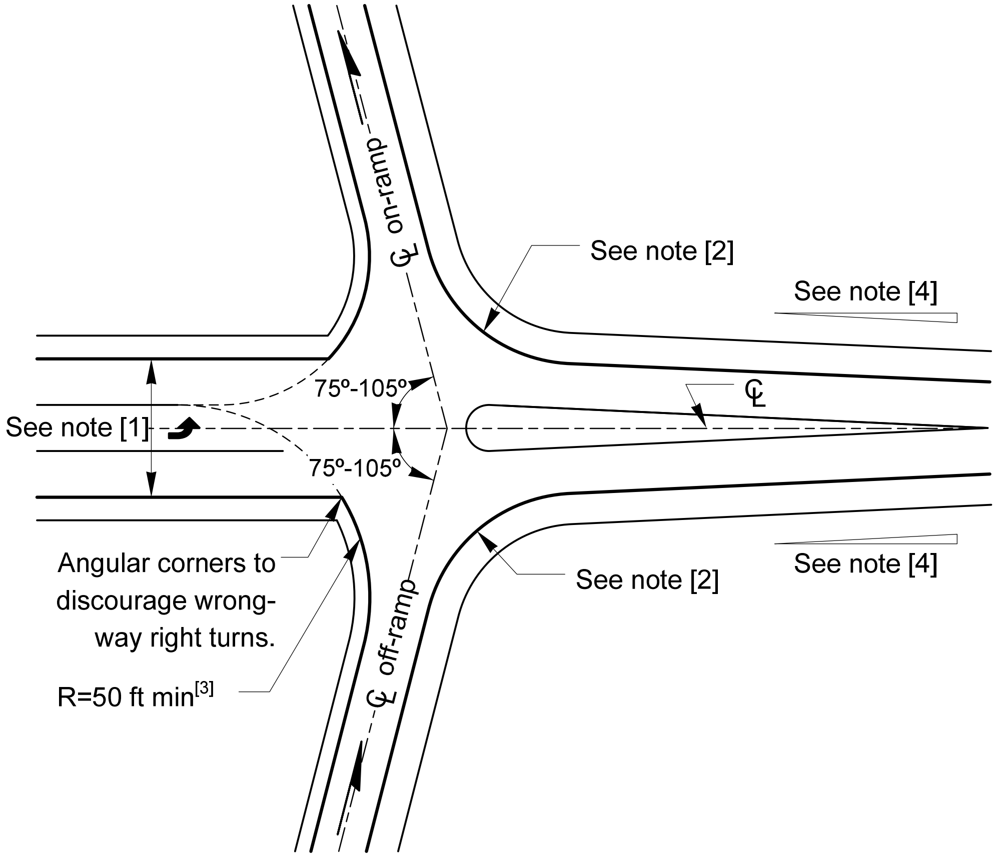
Provide ramp terminal designs consistent with the speed of the crossroad. (See 1310.06 for selection of the design vehicle.)

Where stop control or signal control is implemented, the intersection configuration criteria for ramp terminals are normally the same as for other intersections. One exception is that an angle point is allowed between an off-ramp and an on-ramp. This is because the through movement of traffic getting off the freeway, going through the intersection, and getting back on the freeway is minor.

Another exception is at ramp terminals where the through movement is eliminated (for example, at a single-point interchange). For ramp terminals that have two wye connections, one for right turns and the other for left turns, and no through movement, the intersection angle has little meaning and does not need to be considered.

Due to the probable development of large traffic generators adjacent to an interchange, width for a median on the local road is desirable whenever such development is expected. This allows for future left-turn channelization. Use median channelization when justified by capacity determination and analysis or by the need to provide a smooth traffic flow.

Adjust the alignment of the intersection legs to fit the traffic movements and to discourage wrong-way movements. Use the allowed intersecting angles of 75° to 105°105° to avoid broken back or reverse curves in the ramp alignment.



Notes:

[1] 12-ft through lanes and 13-ft left-turn lane desirable.
[2] For right-turn corner design, see Exhibit 1310-14.
[3] Use templates to verify that the design vehicle can make the turn.
[4] For taper rates, see Exhibit 1310-18a, Table 1.

General:

Ramp terminal intersection design may vary depending on traffic volume, other users, and local conditions.

Interchange Ramp Terminal Details
Exhibit 1310-5

(10) Wrong-Way Movement Countermeasures

Wrong-way collisions, though infrequent, have the potential to be more serious than other types of collisions, especially on high-speed facilities. Collision data show that impaired and older drivers are overrepresented and that a high percentage of these occurrences are at night. Washington State data show approximately equal numbers of collisions on the Interstate and multilane urban principal arterial highways. Give consideration to discouraging wrong-way maneuvers at all stages of design.

(a) Wrong-Way Driving Countermeasure Categories

There are three categories of countermeasures to discourage wrong-way driving:

- Signing and delineation

- Intelligent transportation systems
- Geometric design

1. Signing and Delineation

Signing and delineation countermeasures include:

- DO NOT ENTER and WRONG WAY signs.
- ONE WAY signs.
- Turn restriction signs.
- Red-backed raised pavement markers (RPMs).
- Directional pavement arrows.
- Yellow edge line on left and white edge line on right side of exit ramps.
- Pavement marking extension lines to direct drivers to the correct ramp.

Signing can be a more effective countermeasure when the signs are lowered. At night, lowered signs are better illuminated by low-beam headlights. Other improvements may include a second set of signs, supplemental sign placards, oversized signs, flashing beacons, internal illumination, overhead-mounted signs, red reflective tape on the back of signs, extra overhead lighting, and red-backed guideposts on each side of the ramp up to the WRONG WAY sign.

2. Intelligent Transportation Systems (ITS)

Wrong-way ITS countermeasures are wrong-way detection and warning systems. Contact the region Traffic Office for assistance when considering an ITS wrong-way warning system.

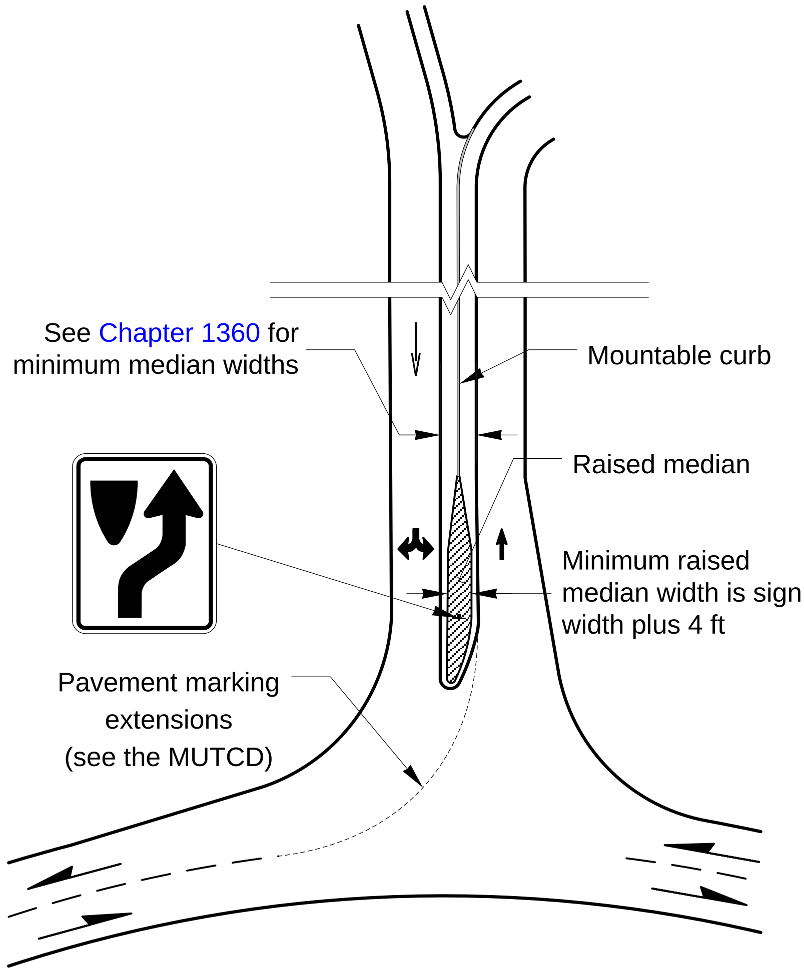
3. Geometric Design

Geometric countermeasures include separating wrong-way movements from other movements, discouraging wrong-way movements, encouraging right-way movements, and improving the visibility of the right-way movement.

a. Separate On- and Off-Ramp Terminals

Consider the separation of on- and off-ramp terminals, particularly at interchanges where the ramp terminals are closely spaced (for example, partial cloverleaf ramps). Wider medians between off- and on-ramp terminals provide room for signing and allow the median end to be shaped to help direct vehicles onto the correct roadway. The minimum width of the raised median is 7 feet, face of curb to face of curb, to accommodate a 36-inch sign.

Extend the raised median on a two-way ramp from the ramp terminal intersection to the split of the on- and off-ramps. The median outside of the intersection area may be reduced to the width of a dual-faced mountable curb. (See Exhibit 1310-6 for an example of the minimum median at the terminal of a two-way ramp.)



Median at Two-Way Ramp Terminal
Exhibit 1310-6

b. Reduced Off-Ramp Terminal Throat Width

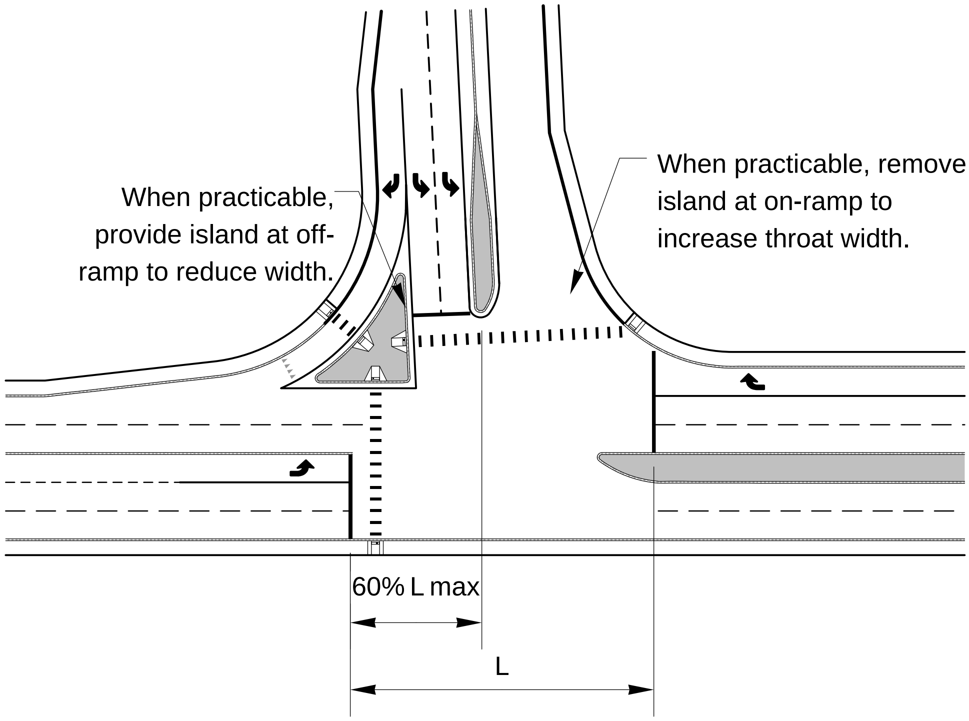
Reducing the width of the off-ramp throat has been a successful method of discouraging wrong-way movements. A smaller opening makes the wrong-way entry less inviting, particularly for closely spaced ramps. When off-ramp terminals have right-turn lanes, a raised island will reduce the potential for a wrong-way movement.

c. Increased On-Ramp Terminal Throat Width

Increasing the width of the on-ramp throat can encourage right-way movements. A larger opening for the on-ramp makes it easier to turn into. To increase the throat width of on-ramps, use flat radii for left- and right-turning traffic and remove islands.

d. Intersection Balance

When drivers make a left turn, they are required to leave the intersection in the extreme left-hand lane lawfully available. As a result, left-turning drivers tend to head for a point between 50% and 60% of the way through the intersection. At a two-way ramp terminal, the desirable throat width for the on-ramp roadway is not less than the off-ramp roadway width to accommodate this behavior (see Exhibit 1310-7). Much of this can be achieved by adjusting the stop bar position on the interchange cross street.



Intersection Balance Example
Exhibit 1310-7

e. Visibility

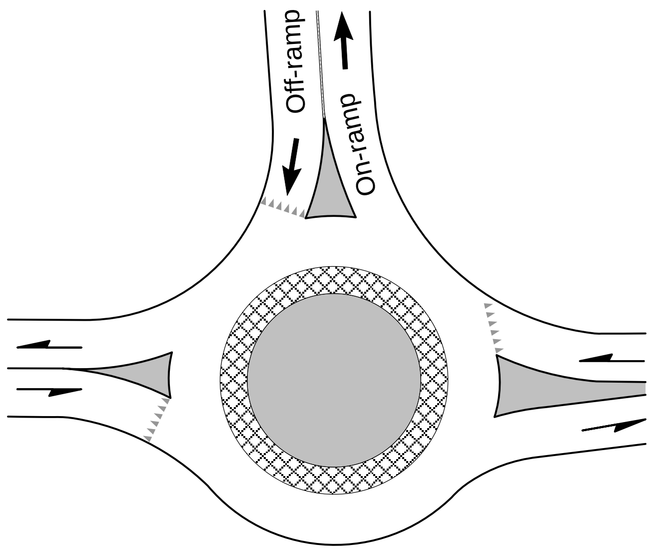
When drivers can see and recognize the roadway they want to turn onto, they are less likely to make a mistake and turn onto the wrong roadway. For two-way ramps and divided multilane roadways with barrier in the median, end the barrier far enough from the intersection that a left-turning driver can see and recognize the roadway going the correct direction. Drivers need to see the delineation pavement markings, curbs, or other elements to locate the correct roadway.

f. Angular Corners on the Left of Off-Ramp Terminals

Angular corners on the left side of off-ramp terminals will discourage wrong-way right turns. Provide a corner design as angular as feasible that will provide for the left turn from the off-ramp. Circular curves can look inviting for a wrong-way right turn onto the off-ramp (see Exhibit 1310-5).

g. Roundabouts

The design of roundabouts makes wrong-way movement less likely. Where wrong-way driving is a concern, evaluate a roundabout as an alternative. (See Exhibit 1310-8 for an example of a roundabout at a two-way ramp terminal.)



Roundabout at a Two-Way Ramp Terminal
Exhibit 1310-8

(b) Countermeasure Applications

Following are applications of wrong-way countermeasures for some common locations. For assistance with signing and delineation, contact the region Traffic Office.

1. All Ramps

Countermeasures that can be used on almost any ramp or intersection with potential wrong-way concerns include:

- Enlarged warning signs.
- Directional pavement arrows at ramp terminals.
- Redundant signing and pavement arrows.
- Roundabout ramp terminal intersections, where room is available.
- Red-backed RPMs

2. One-Way Diamond Off-Ramp

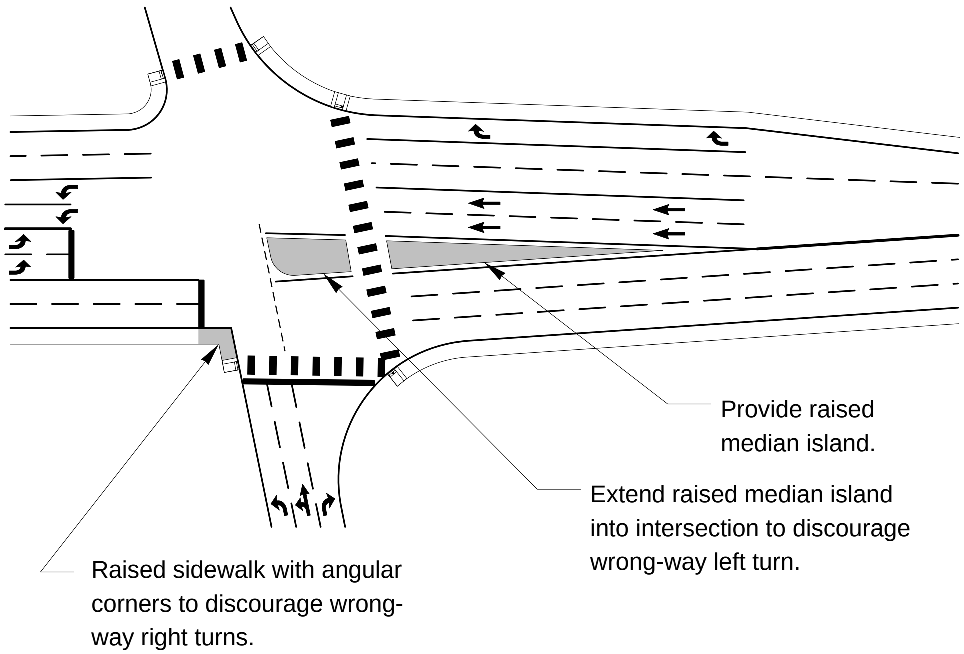
Diamond interchanges are common, and although drivers are familiar with them, they can still get confused and go the wrong way. In addition to signing and pavement markings for these interchanges, provide:

- Angular corners to discourage wrong-way right turns.

3. Diamond Interchange With Advance Storage

Diamond interchanges with advance storage have left-turn storage lanes that extend from the on-ramp past the off-ramp (see Exhibit 1310-9). This allows for a potential early left turn onto the off-ramp. Following are additional countermeasures for interchanges with advanced left-turn storage:

- Provide a raised median to discourage the wrong-way left turn.
- Provide signing and directional arrows to direct traffic to the correct left-turn point.



Diamond Interchange With Advance Storage
Exhibit 1310-9

4. Two-Way Ramps

Two-way ramps have the on- and off-ramp adjacent to each other. They are used at partial cloverleaf, trumpet, and button hook interchanges. Because the on and off roadways are close to each other, they are more vulnerable to wrong-way driving. Also, when the separation between on and off traffic is striping only, the ramps are susceptible to drivers entering the correct roadway and inadvertently crossing to the wrong ramp. In addition to signing and delineation, the following are countermeasures for two-way ramps:

- Separate the on- and off-ramp terminals.
- Reduce off-ramp terminal throat width.
- Increase on-ramp terminal throat width.
- Maintain intersection balance.
- Improve on-ramp visibility.
- Provide a raised median or dual-faced curb from the ramp terminal intersection to the gore nose.

5. HOV Direct Access Ramps

HOV direct access ramps are two-way ramps in the median; therefore, the ability to provide separation between the on and off traffic is limited by the width of the median. An additional concern is that HOV direct access ramps are left-side ramps. Drivers normally enter the freeway using a right-side ramp and they may mistakenly travel the wrong way on a left-side ramp. Review existing and proposed signing for inadvertent misdirection.

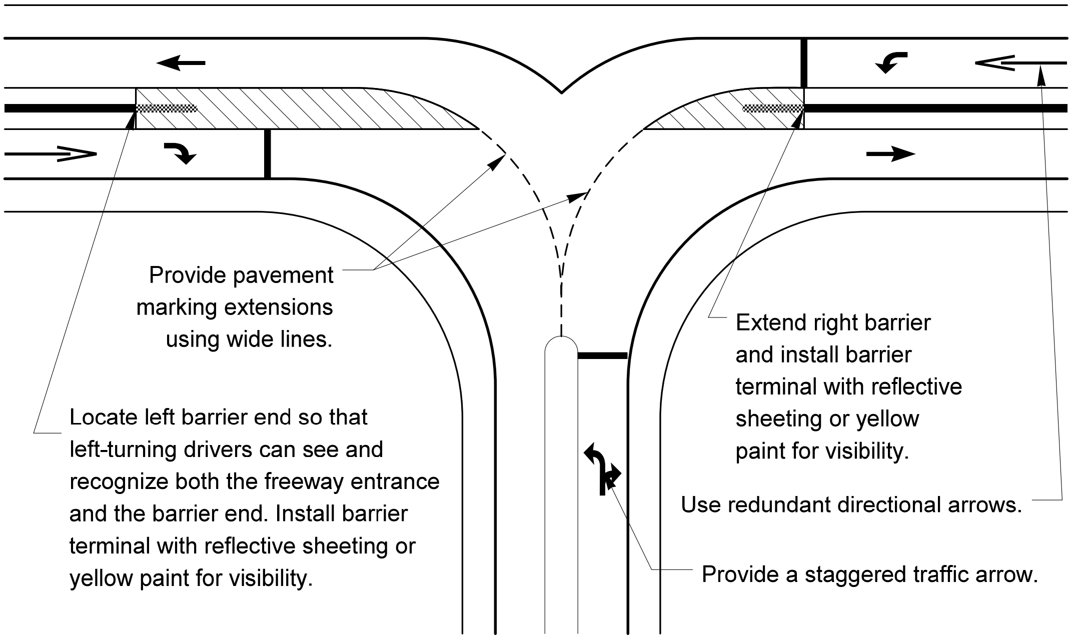
Following are countermeasures for wrong-way driving at HOV direct access ramps:

- Provide a staggered traffic arrow to better describe the left and right turns (see Exhibit 1310-10a).
- Provide pavement marking extensions, using wide lines, through intersections (see Exhibit 1310-10a).
- Use redundant directional pavement arrows at ramp terminals.
- Paint or use reflective sheeting to highlight barrier terminals (see Exhibit 1310-10a).
- Locate the left barrier end to provide good visibility for left-turning traffic for both the barrier terminal and the on-ramp roadway.
- Extend right barrier as far as feasible while providing a 4-foot clearance for the left-turning exiting design vehicle.
- Provide redundant signing (see Exhibit 1310-10b).
- Provide enlarged warning signs.

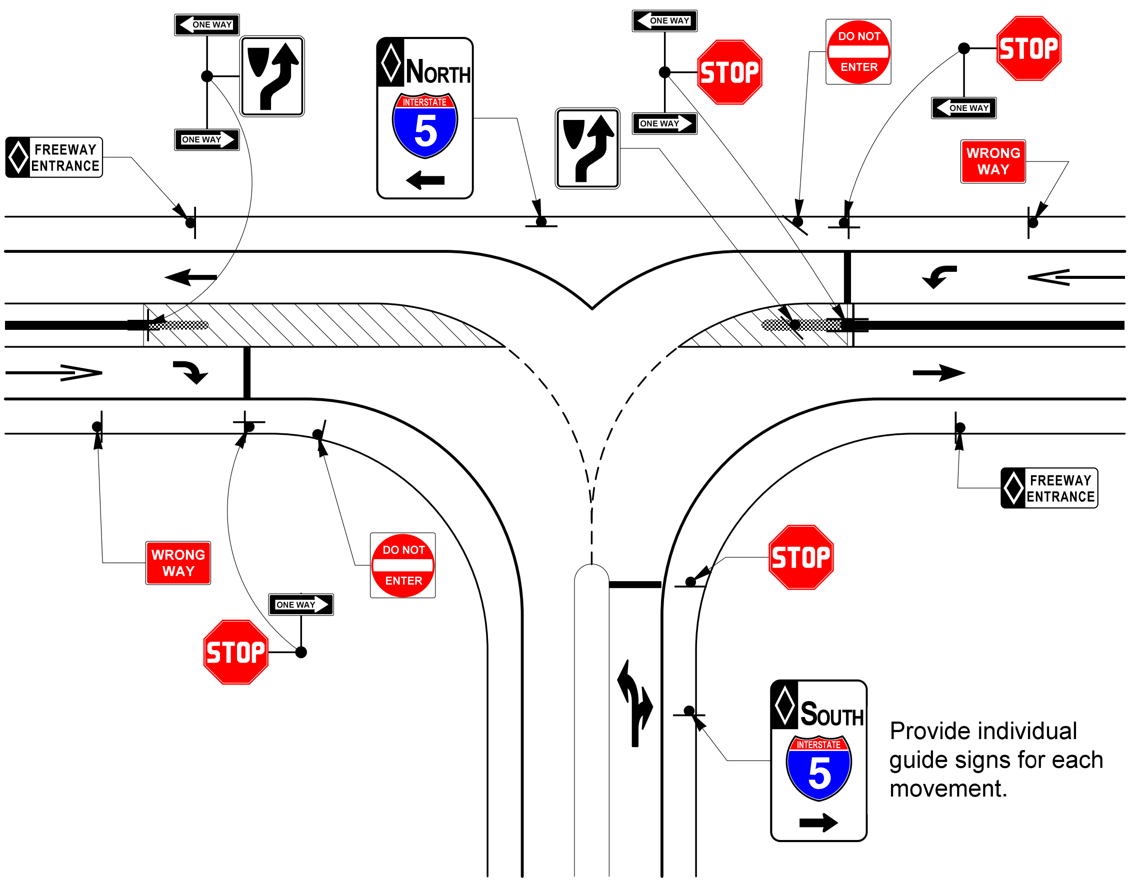
6. Multilane Divided Roadways

Wrong-way driving can also occur on multilane divided nonfreeway facilities. Wrong-way drivers may enter multilane divided facilities at driveways and at-grade intersections. Countermeasures for wrong-way driving on nonfreeway multilane divided highways include:

- Wrong-way signing and delineation at the intersections.
- Right-in/right-out road approaches.



HOV Direct Access: Pavement Markings
Exhibit 1310-10a



HOV Direct Access: Signing
Exhibit 1310-10b

1310.06 Design Vehicle Selection

When selecting a design vehicle for an intersection, consider the needs of all users and the costs. The primary use of the design vehicle is to determine radii for each leg of the intersection. It is possible for each leg to have a different design vehicle. Exhibit 1310-11 shows commonly used design vehicle types.

Evaluate the existing and anticipated future traffic to select a design vehicle that is the largest vehicle that normally uses the intersection. Exhibit 1310-12 shows the minimum design vehicles. Provide justification to use a smaller vehicle; include a traffic analysis showing that the proposed vehicle is appropriate.

To minimize the disruption to other traffic, design the intersection to allow the design vehicles to make each turning movement without encroaching on curbs, opposing lanes, or same-direction lanes at the entrance leg. Use turning path templates (Exhibits 1310-13a through 13c, other published templates, or computer-generated templates) to verify that the design vehicle can make the turning movements.

Encroachment on the same-direction lanes of the exit leg and the shoulder might be necessary to minimize crosswalk distances; however, this might negatively impact vehicular operations. Document and justify the operational tradeoffs associated with this encroachment. When encroachment on the shoulder is required, increase the pavement structure to support the anticipated traffic.

Vehicle Type	Design Symbol
Passenger car, including light delivery trucks	P
Single-unit bus	BUS
Articulated bus	A-BUS
Single-unit truck	SU
Semitrailer truck, overall wheelbase of 40 ft	WB-40
Semitrailer truck, overall wheelbase of 50 ft	WB-50
Semitrailer truck, overall wheelbase of 67 ft	WB-67
Motor home	MH
Passenger car pulling a camper trailer	P/T
Motor home pulling a boat trailer	MH/B

Design Vehicle Types
Exhibit 1310-11

Intersection Type	Minimum Design Vehicle
Junction of Major Truck Routes	WB-67
Junction of State Routes	WB-50[1]
Ramp Terminals	WB-50[1]
Other Rural	WB-50
Industrial	WB-40
Commercial	SU[2][3]
Residential	SU[2][3]

Notes:
[1] WB-67 is desirable.
[2] To accommodate pedestrians, the P vehicle may be used as the design vehicle if justification, with a traffic analysis, is documented.
[3] When the intersection is on a transit or school bus route, use the BUS design vehicle as a minimum. (See Chapter 1430 for additional guidance on transit facilities.)

Minimum Intersection Design Vehicle
Exhibit 1310-12

In addition to the design vehicle, design intersections to accommodate the occasional larger vehicle. When vehicles larger than the design vehicle are allowed and are anticipated to occasionally use the intersection, make certain they can make the turn without leaving the paved shoulders or encroaching on a sidewalk. The amount of encroachment allowed is dependent on the frequency of vehicle usage and the resulting disruption to other traffic. Use the WB-67 as the largest vehicle at state route-to-state route junctions. Consider oversized vehicles for intersections that are commonly used to route oversized loads. Document and justify any required encroachment into other lanes and any degradation of intersection operation in an evaluate upgrade.

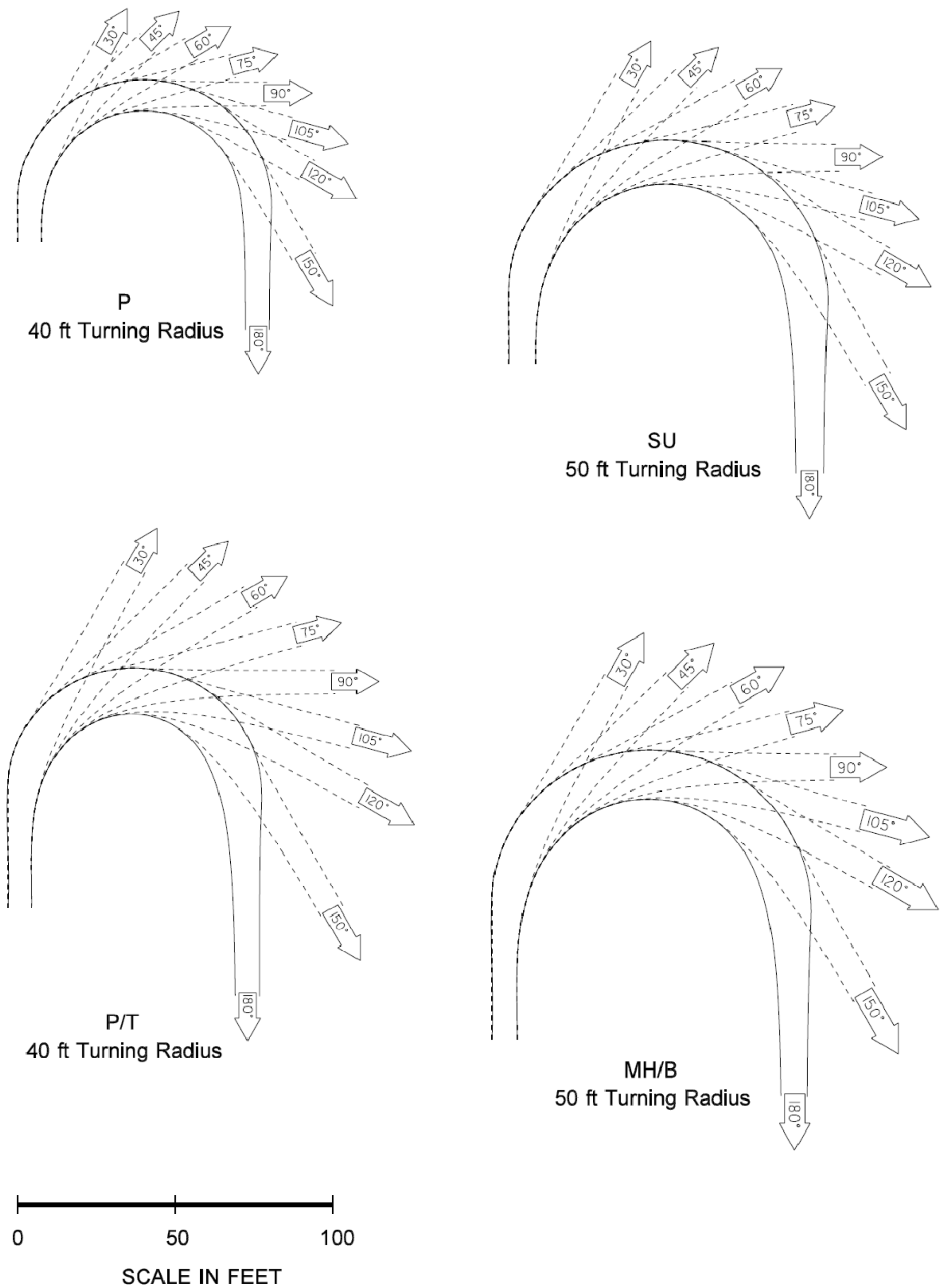
1310.07 Design Elements

When designing an intersection, identify and address the needs of all intersection users.

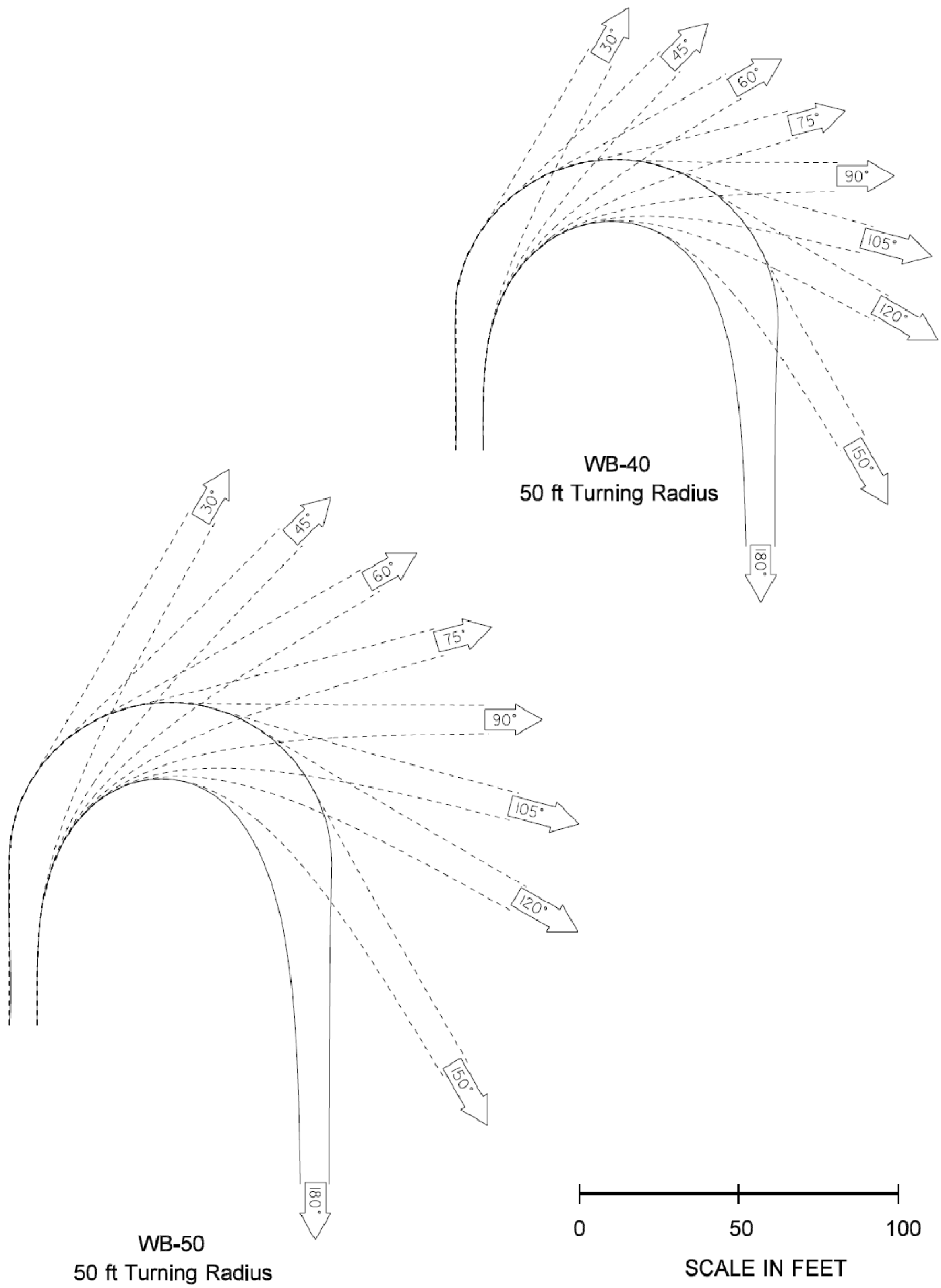
When pedestrian issues are a primary concern, the design objective becomes one of reducing the potential for vehicle/pedestrian conflicts. This is done by minimizing pedestrian crossing distances and controlling the speeds of turning vehicles. This normally leads to right-corner designs with smaller turning radii. The negative impacts include possible capacity reductions and greater speed differences between turning vehicles and through vehicles.

Pedestrian refuge islands can be beneficial. They minimize the pedestrian crossing distance, reduce the conflict area, and minimize the impacts on vehicular traffic. When designing islands, speeds can be reduced by designing the turning roadway with a taper or large radius curve at the beginning of the turn and a small radius curve at the end. This allows larger islands while forcing the turning traffic to slow down.

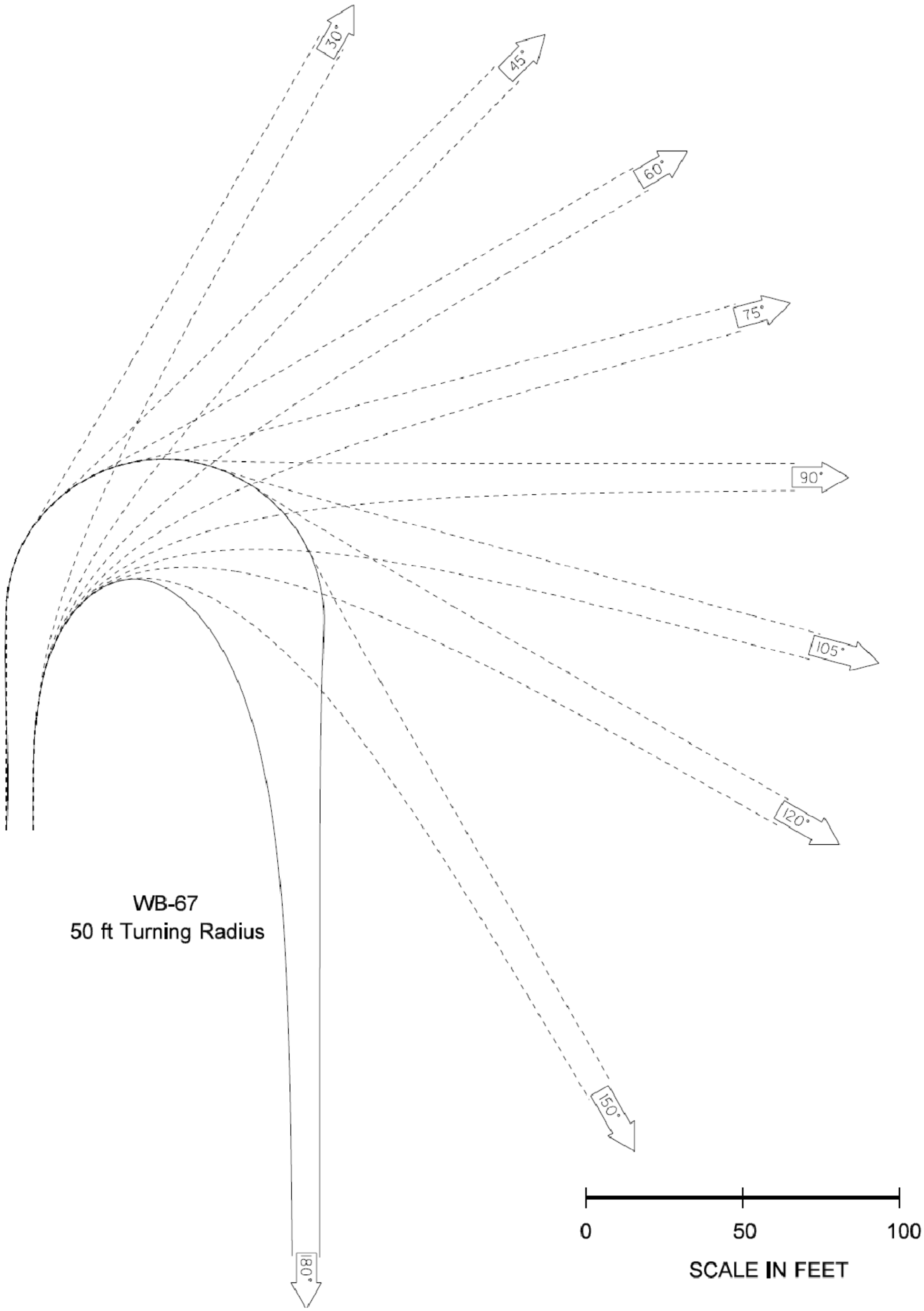
Channelization, the separation or regulation of traffic movements into delineated paths of travel, can facilitate the orderly movement of vehicles, bicycles, and pedestrians. Channelization includes left-turn lanes, right-turn lanes, speed change lanes (both acceleration and deceleration lanes), and islands.



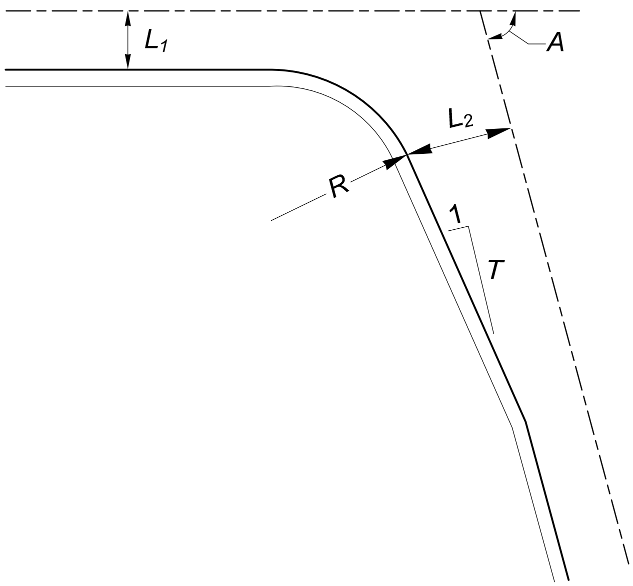
Turning Path Template
Exhibit 1310-13a



Turning Path Template
Exhibit 1310-13b



Turning Path Template
Exhibit 1310-13c



L_1 = Minimum available roadway width[2] that the vehicle is turning from

L_2 = Available roadway width[2] for the vehicle leaving the intersection

R = Radius to the edge of traveled way

T = Taper rate (length per unit of width of widening)

A = Delta angle of the turning vehicle

Vehicle	*A*	*R*	L_1[1]	L_2[2]	*T*	Vehicle	*A*	*R*	L_1[1]	L_2[2]	*T*
WB-67	60	85	11	22	7	WB-40	60	55	11	15	7.5
	75	75	11	21	8		75	55	11	15	7.5
	90	70	11	21	8		90	55	11	14	7.5
	105	55	11	24	7		105	45	11	16	7.5
	120	50	11	24	7		120	45	11	15	7.5
WB-50	60	55	11	19	6	SU & BUS	All	50	11	11	25
	75	55	11	18	6	P	All	35	11	11	25
	90	55	11	17	6						
	105	50	11	17	6						
	120	45	11	18	6						

Notes:

[1] When available roadway width is less than 11 ft, widen at 25:1.

[2] Available roadway width includes the shoulder, less a 2-ft clearance to a curb, and all the same-direction lanes of the exit leg at signalized intersections.

General:

All distances given in feet and angles in degrees.

Right-Turn Corner

Exhibit 1310-14

(1) Right-Turn Corners

Exhibit 1310-14 shows right-turn corner designs for the design vehicles. These are considered the minimum pavement area to accommodate the design vehicles without encroachment on the adjacent lane at either leg of the curve.

With an evaluate upgrade, the right-turn corner designs given in Exhibit 1310-14 may be modified. Document the benefits and impacts of the modified design, including changes to vehicle-pedestrian conflicts; vehicle encroachment on the shoulder or adjacent same-direction lane at the exit leg; capacity restrictions for right-turning vehicles or other degradation of intersection operations; and the effects on other traffic movements. To verify that the design vehicle can make the turn, include a plot of the design showing the design vehicle turning path template.

(2) Left-Turn Lanes and Turn Radii

Left-turn lanes provide storage, separate from the through lanes, for left-turning vehicles waiting for a signal to change or for a gap in opposing traffic. (See 1310.07(4) for a discussion on speed change lanes.)

Design left-turn channelization to provide sufficient operational flexibility to function under peak loads and adverse conditions.

(a) One-Way Left-Turn Lanes

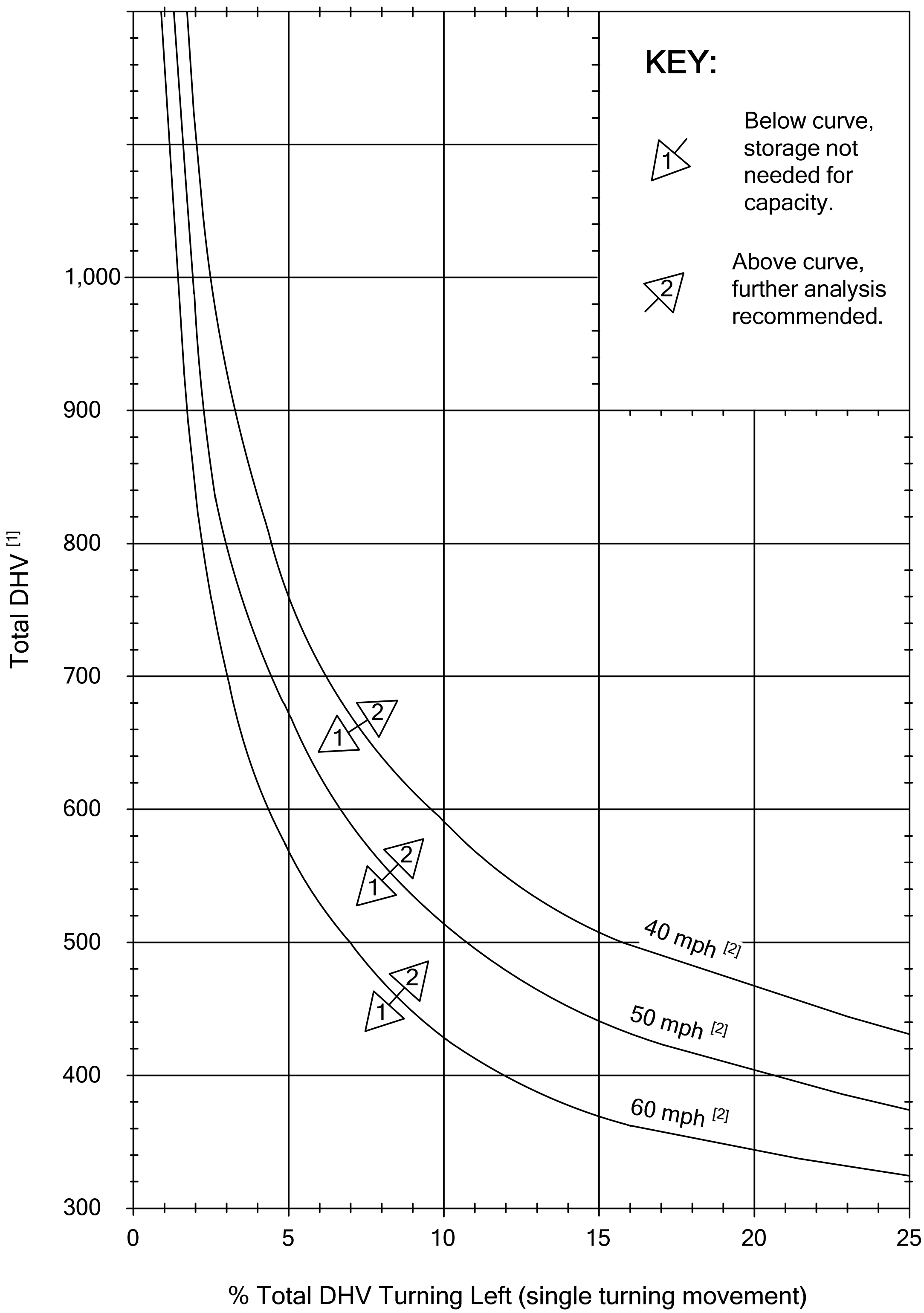
One-way left-turn lanes are separate storage lanes for vehicles turning left from one roadway onto another. One-way left-turn lanes may be an economical way to lessen delays and crash potential involving left-turning vehicles. In addition, they can allow deceleration clear of the through traffic lanes. Provide a minimum storage length of 100 feet for one-way left-turn lanes. When evaluating left-turn lanes, include impacts to all intersection movements and users.

At signalized intersections, use a traffic signal analysis to determine whether a left-turn lane is needed and the storage length. If the length determined is less than the 100-foot minimum, make it 100 feet (see Chapter 1330).

At unsignalized intersections, use the following as a guide to determine whether or not to provide one-way left-turn lanes:

- A traffic analysis indicates congestion reduction with a left-turn lane. On two-lane highways, use Exhibit 1310-15a, based on total traffic volume (DHV) for both directions and percent left-turn traffic, to determine whether further investigation is needed. On four-lane highways, use Exhibit 1310-15b to determine whether a left-turn lane is recommended.
- A study indicates crash reduction with a left-turn lane.
- Restrictive geometrics require left-turning vehicles to slow greatly below the speed of the through traffic.
- There is less than decision sight distance for traffic approaching a vehicle stopped at the intersection to make a left-turn.

A traffic analysis based on the *Highway Capacity Manual* (HCM) may also be used to determine whether left-turn lanes are needed to maintain the desired level of service.

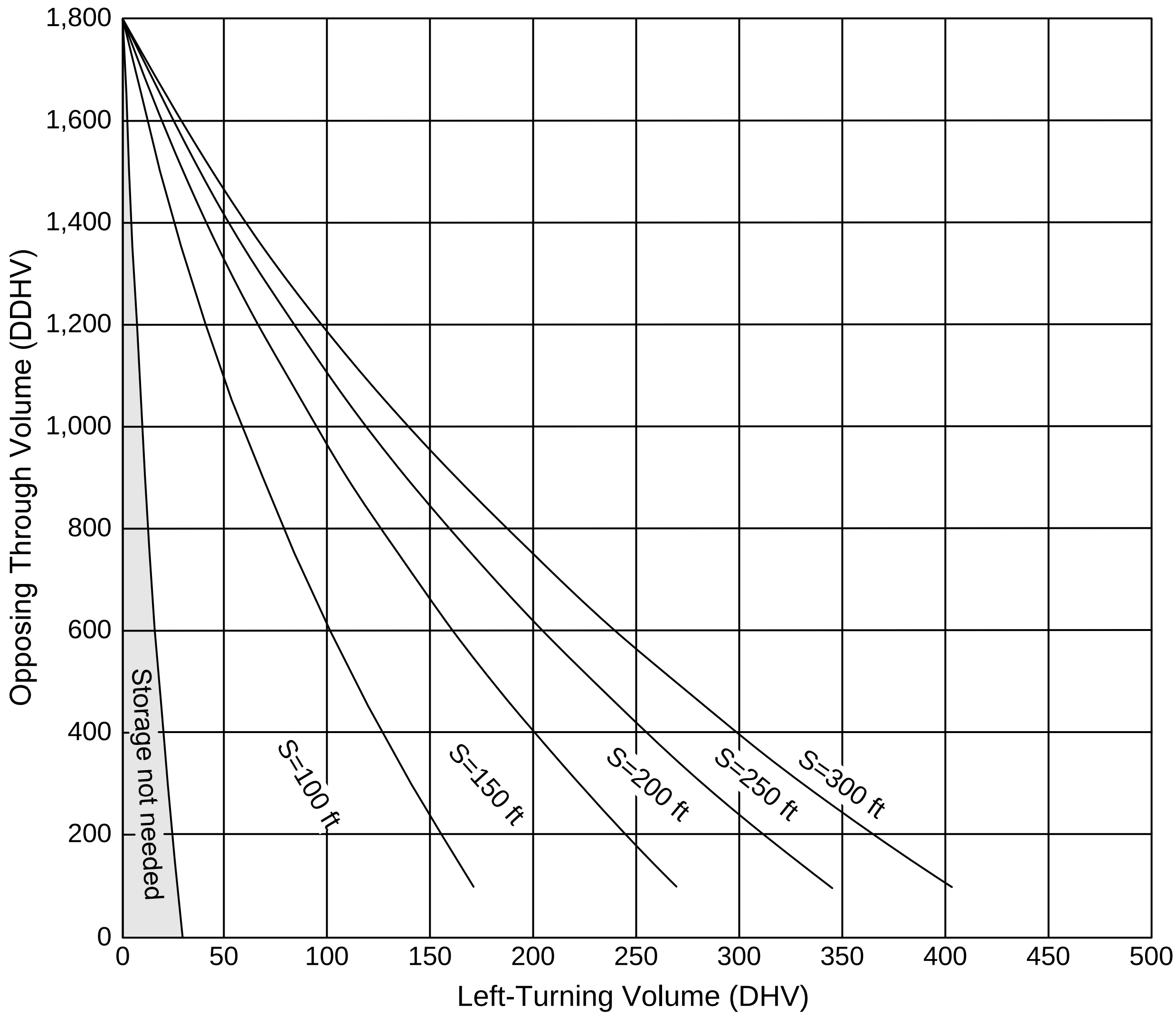


Notes:

[1] DHV is total volume from both directions.

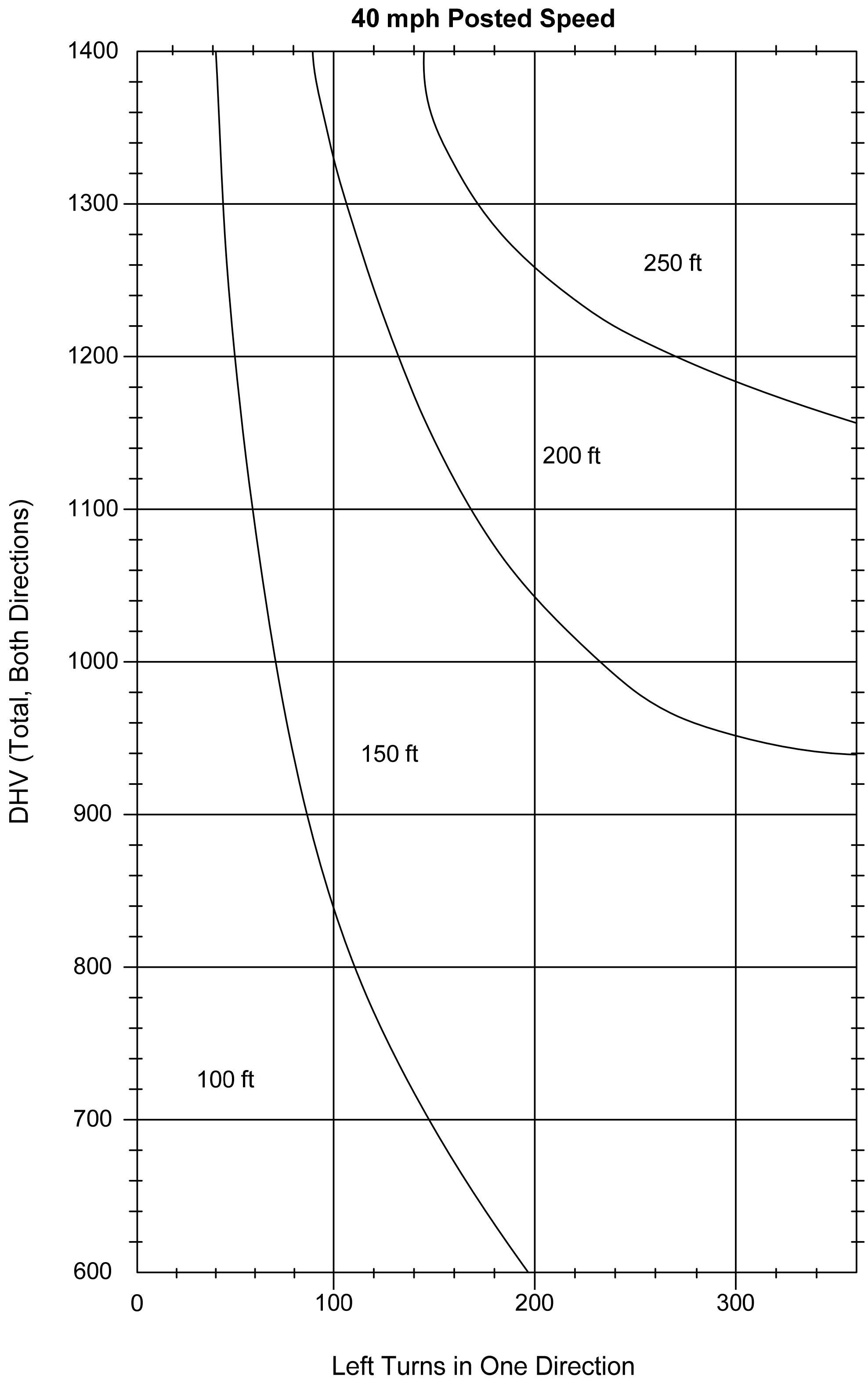
[2] Speeds are posted speeds.

Left-Turn Storage Guidelines: Two-Lane, Unsignalized
Exhibit 1310-15a

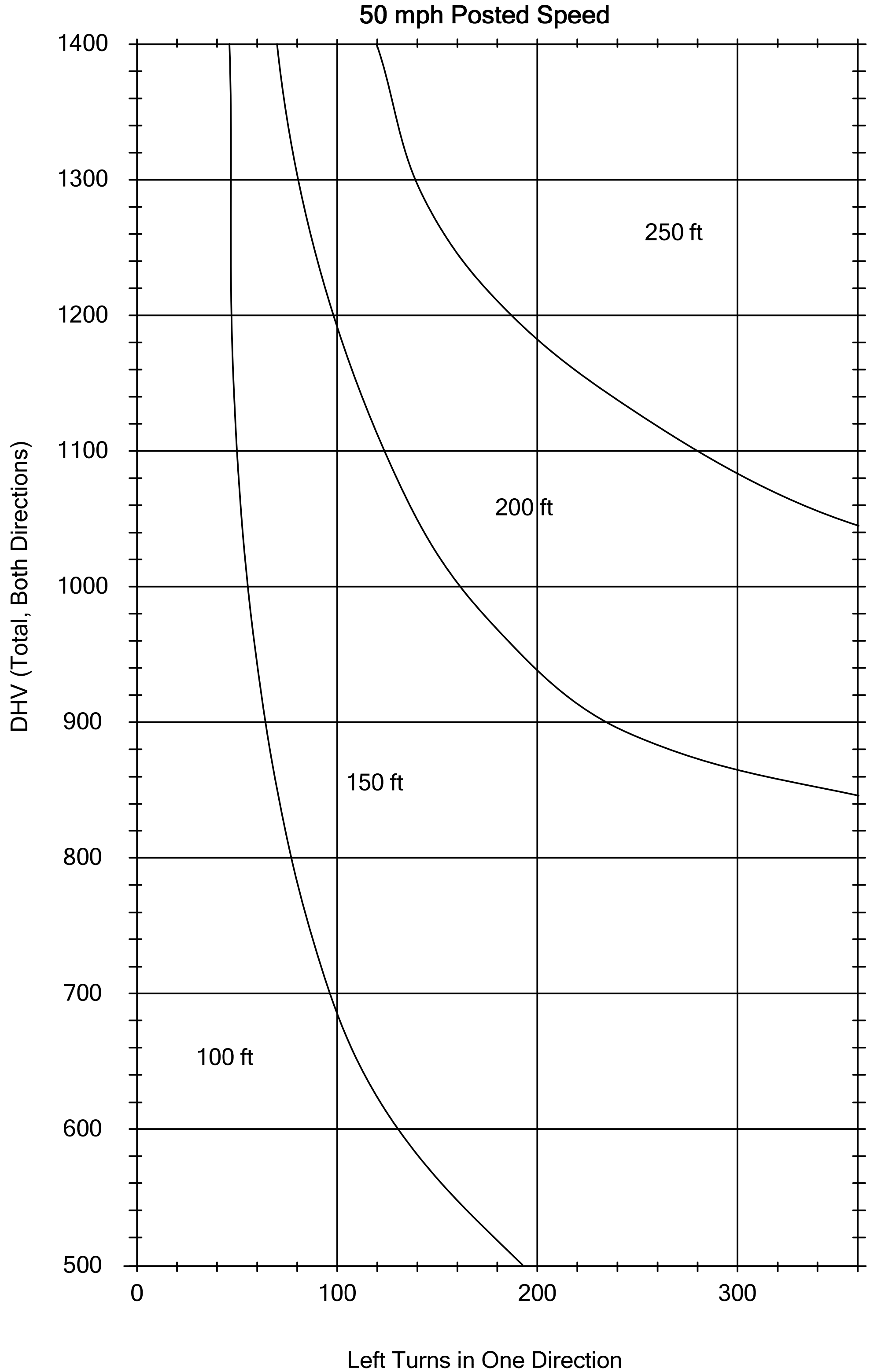


S = Left-turn storage length

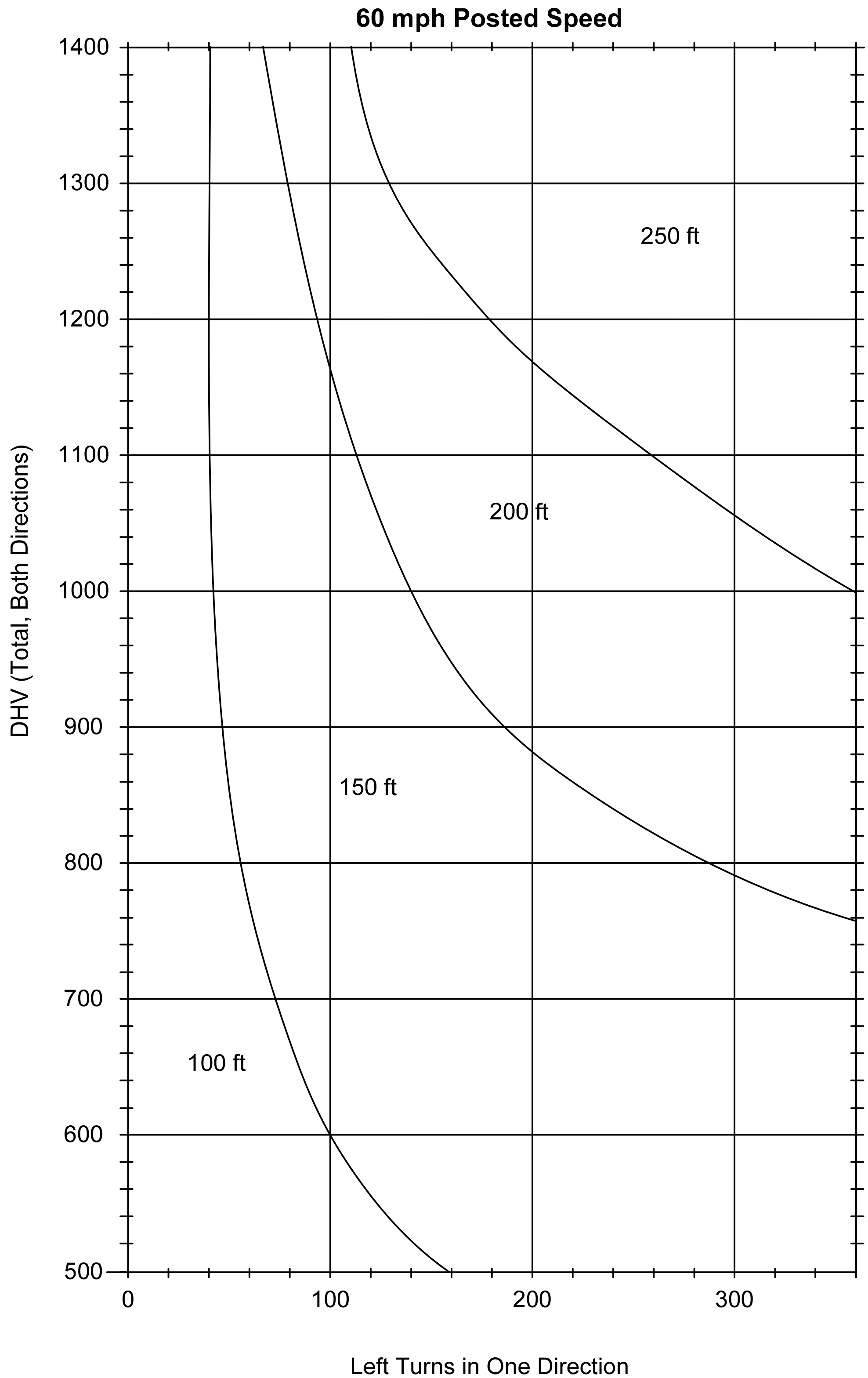
Left-Turn Storage Guidelines: Four-Lane, Unsignalized
Exhibit 1310-15b



Left-Turn Storage Length: Two-Lane, Unsignalized
Exhibit 1310-16a



Left-Turn Storage Length: Two-Lane, Unsignalized
Exhibit 1310-16b



Left-Turn Storage Length: Two-Lane, Unsignalized
Exhibit 1310-16c

Determine the storage length on two-lane highways by using Exhibits 1310-16a through 16c. On four-lane highways, use Exhibit 1310-15b. These lengths do not consider trucks. Use Exhibit 1310-17 for storage length when trucks are present.

Storage Length* (ft)	% Trucks in Left-Turn Movement				
	10	20	30	40	50
100	125	125	150	150	150
150	175	200	200	200	200
200	225	250	275	300	300
250	275	300	325	350	375
300	350	375	400	400	400

*Length from Exhibits 1310-15b and 1310-16a, 16b, or 16c.

Left-Turn Storage With Trucks (ft)
Exhibit 1310-17

Use turning templates to verify that left-turn movements for the design vehicle(s) do not have conflicts. Design opposing left-turn design vehicle paths with a minimum 4-foot (12-foot desirable) clearance between opposing turning paths.

Where one-way left-turn channelization with curbing is to be provided, evaluate surface water runoff and design additional drainage facilities if needed to control the runoff.

Provide illumination at left-turn lanes in accordance with the guidelines in Chapter 1040.

At signalized intersections with high left-turn volumes, double (or triple) left-turn lanes may be needed to maintain the desired level of service. For a double left-turn, a throat width of 30 to 36 feet is desirable on the exit leg of the turn to offset vehicle offtracking and the difficulty of two vehicles turning abreast. Use turning path templates to verify that the design vehicle can complete the turn. Where the design vehicle is a WB 40 or larger, it is desirable to provide for the design vehicle in the outside lane and an SU vehicle turning abreast rather than two design vehicles turning abreast.

Exhibits 1310-18a through 18f show left-turn lane geometrics, which are described as follows:

1. Widening

It is desirable that offsets and pavement widening (see Exhibit 1310-18a) be symmetrical about the centerline or baseline. Where right of way or topographic restrictions, crossroad alignments, or other circumstances preclude symmetrical widening, pavement widening may be on one side only.

2. Divided Highways

Widening is not needed for left-turn lane channelization where medians are 11 feet wide or wider (see Exhibits 1310-18b through 18d). For medians between 13 feet and 23 feet or where the acceleration lane is not provided, it is desirable to design the left-turn lane adjacent to the opposing lane (see Exhibit 1310-18b) to improve sight distance and increase opposing left-turn clearances.

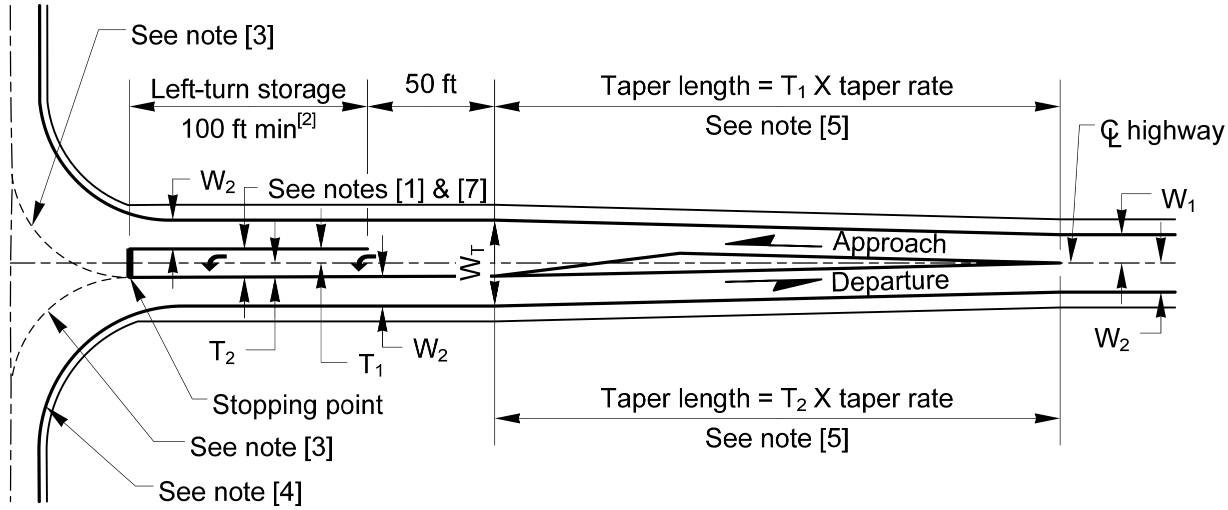
A median acceleration lane (see Exhibits 1310-18c and 18d) may be provided where the median is 23 feet or wider. The median acceleration lane might not be needed at a signalized intersection. When a median acceleration lane is to be used, design it in accordance with 1310.07(4), Speed Change Lanes. Where medians have sufficient width, provide a 2-foot shoulder adjacent to a left-turn lane.

3. Minimum Protected Left Turn With a Median

At intersections on divided highways where channelized left-turn lanes are not provided, provide the minimum protected storage area (see Exhibit 1310-18e).

4. Modifications to Left-Turn Designs

With an evaluate upgrade, the left-turn lane designs discussed above and given in Exhibits 1310-18a through 18e may be modified. Document the benefits and impacts of the modified design, including changes to vehicle-pedestrian conflicts; vehicle encroachment; deceleration length; capacity restrictions for turning vehicles or other degradation of intersection operations; and the effects on other traffic movements. Provide a modified design that is able to accommodate the design vehicle, and provide for the striping (see the *Standard Plans* and the MUTCD). To verify that the design vehicle can make the turn, include a plot of the design showing the design vehicle turning path template.



Notes:

[1] The minimum width of the left-turn storage lane (T_1+T_2) is 11 ft. The desirable width is 12 ft.

[2] For left-turn storage length, see Exhibits 1310-15b for 4-lane roadways or 1310-16a through 16c for 2-lane roadways.

[3] Desirable radius not less than 50 ft. Use templates to verify that the design vehicle can make the turn.

[4] For right-turn corner design, see Exhibit 1310-14.

[5] For desirable taper rates, see Table 1. With justification, taper rates from Table 2, Exhibit 1310-18c, may be used.

[6] For pavement marking details, see the *Standard Plans* and the MUTCD.

[7] When curb is provided, add the width of the curb and the shoulders to the left-turn lane width. For shoulder widths at curbs, see 1310.07(6) and Chapter 1240.

W_1= Approaching through lane width

W_2= Departing lane width

T_1 = Width of left-turn lane on approach side of centerline

T_2 = Width of left-turn lane on departure side of centerline

W_T= Total width of left-turn lane

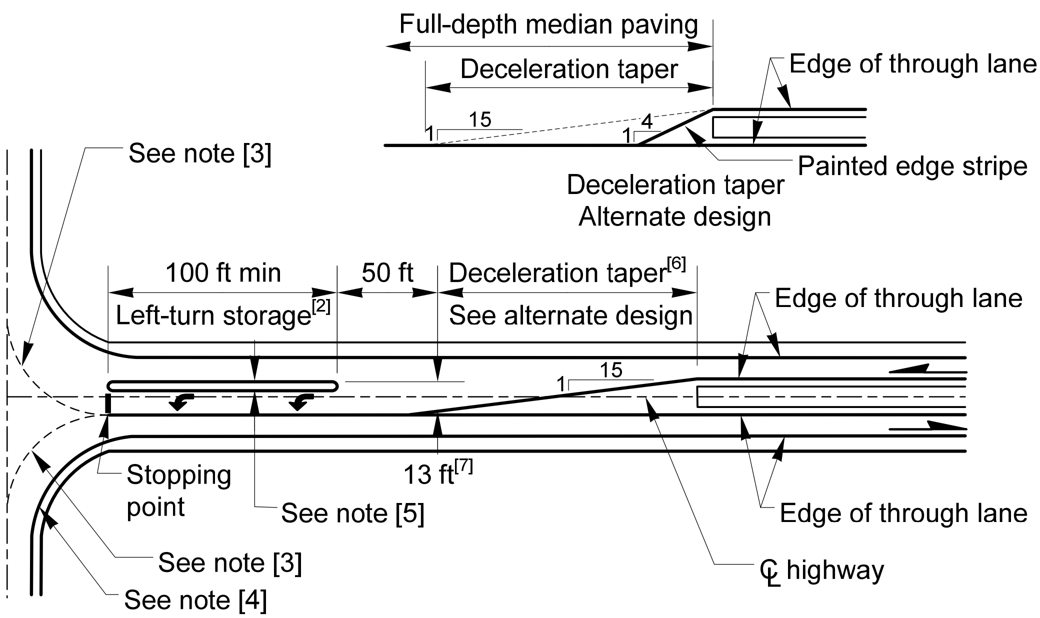
W = Total width of channelization (W_1+W_2+T_1+T_2)

Posted Speed	Desirable Taper Rate[6]
55 mph	55:1
50 mph	50:1
45 mph	45:1
40 mph	40:1
35 mph	35:1
30 mph	30:1
25 mph	25:1

Table 1

Median Channelization: Widening

Exhibit 1310-18a



Notes:

[1] Lane width of 13 ft is desirable. When curb is provided, add the width of the curb and the shoulders. For shoulder widths at curbs, see 1310.07(6) and Chapter 1240.

[2] For left-turn storage length, see Exhibits 1310-15b for 4-lane roadways or 1310-16a through 16c for 2-lane roadways.

[3] Desirable radius not less than 50 ft. Use templates to verify that the design vehicle can make the turn.

[4] For right-turn corner design, see Exhibit 1310-14.

[5] For median widths greater than 13 ft, it is desirable to locate the left-turn lane adjacent to the opposing through lane with excess median width between the same-direction through lane and the turn lane.

[6] For increased storage capacity, the left-turn deceleration taper alternate design may be used.

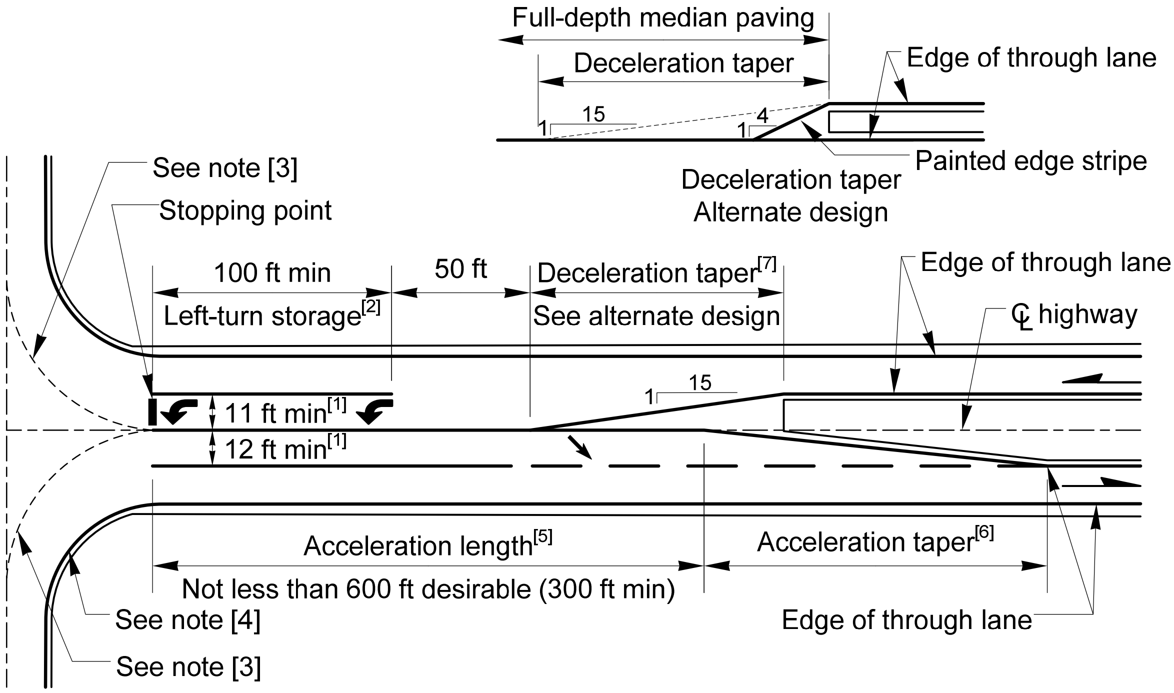
[7] Reduce to lane width for medians less than 13 ft wide.

General:

For pavement marking details, see the *Standard Plans* and the MUTCD.

Median Channelization: Median Width 11 ft or More

Exhibit 1310-18b



Notes:

[1] Lane widths of 13 ft are desirable for both the left-turn storage lane and the median acceleration lane. When curb is provided, add the width of the curb.

[2] For left-turn storage length, see Exhibits 1310-15b for 4-lane roadways or 1310-16a through 16c for 2-lane roadways.

[3] Desirable radius not less than 50 ft. Use templates to verify that the design vehicle can make the turn.

[4] For right-turn corner design, see Exhibit 1310-14.

[5] The minimum total length of the median acceleration lane is shown in Exhibit 1310-22.

[6] For acceleration taper rate, see Table 2.

[7] For increased storage capacity, the left-turn deceleration taper alternate design may be used.

Posted Speed	Taper Rate
55 mph	55:1
50 mph	50:1
45 mph	45:1
40 mph	27:1
35 mph	21:1
30 mph	15:1
25 mph	11:1

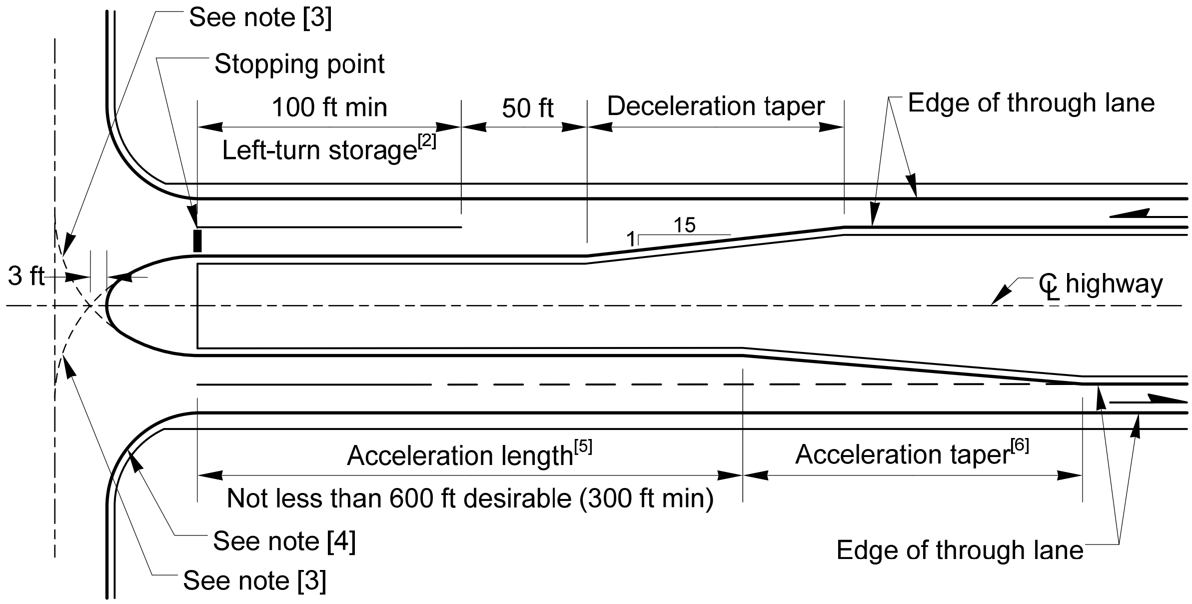
Table 2

General:

For pavement marking details, see the *Standard Plans* and the MUTCD.

Median Channelization: Median Width 23 ft to 26 ft

Exhibit 1310-18c



Notes:

[1] May be reduced to 11 ft, with justification.

[2] For left-turn storage length, see Exhibits 1310-15b for 4-lane roadways or 1310-16a through 16c for 2-lane roadways.

[3] Desirable radius not less than 50 ft. Use templates to verify that the design vehicle can make the turn.

[4] For right-turn corner design, see Exhibit 1310-14.

[5] The minimum length of the median acceleration lane is shown in Exhibit 1310-22.

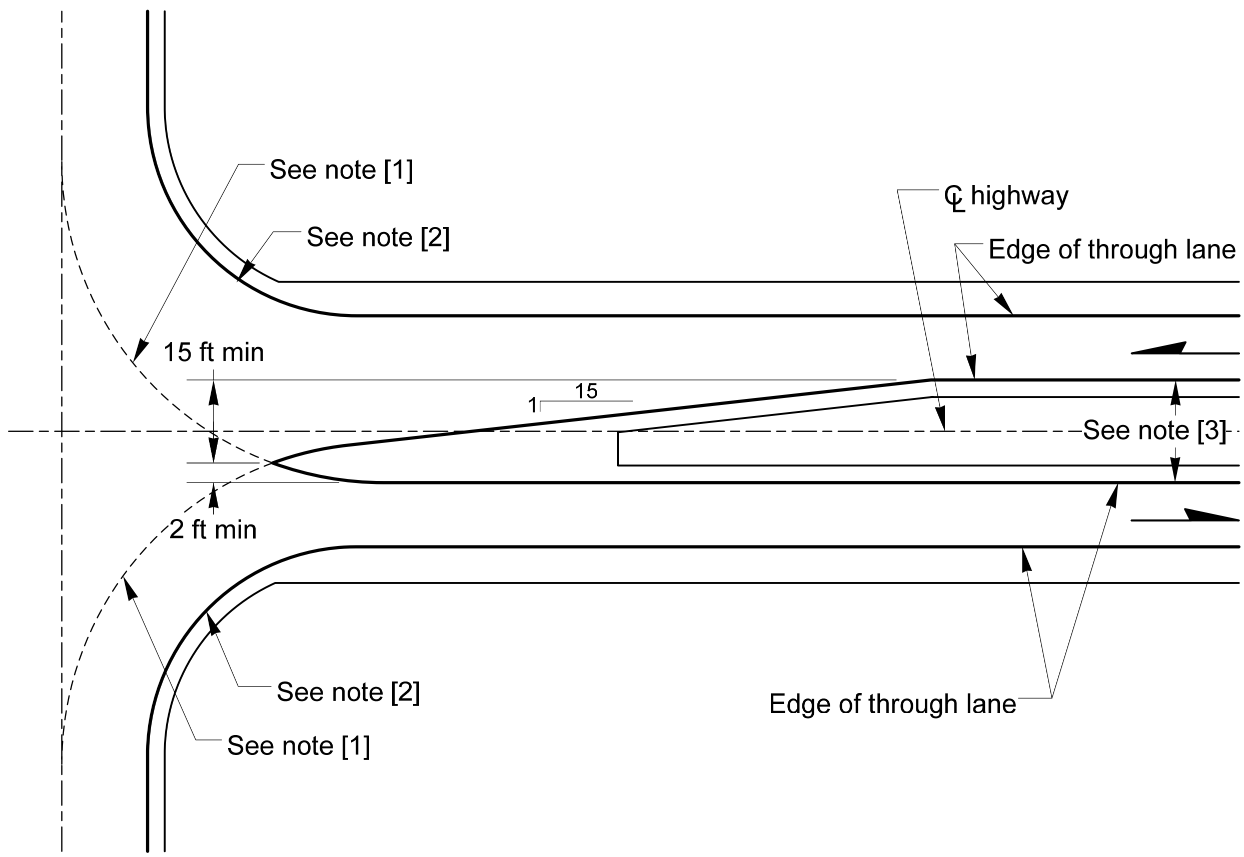
[6] For acceleration taper rate, see Exhibit 1310-18c, Table 2.

General:

For pavement marking details, see the *Standard Plans* and the MUTCD.

Median Channelization: Median Width of More Than 26 ft

Exhibit 1310-18d



Notes:

[1] Desirable radius not less than 50 ft. Use templates to verify that the design vehicle can make the turn.

[2] For right-turn corner design, see Exhibit 1310-14.

[3] For median width 17 ft or more. For median width less than 17 ft, widen to 17 ft or use Exhibit 1310-18b.

General:

For pavement marking details, see the *Standard Plans* and the MUTCD.

Median Channelization: Minimum Protected Storage

Exhibit 1310-18e

(b) Two-Way Left-Turn Lanes (TWLTL)

Two-way left-turn lanes are located between opposing lanes of traffic. They are used by vehicles making left turns from either direction, from or onto the roadway.

Use TWLTLs only on managed access highways where there are no more than two through lanes in each direction. Evaluate installation of TWLTLs where:

- An accident study indicates reduced crashes with a TWLTL.
- There are existing closely spaced access points or minor street intersections.
- There are unacceptable through traffic delays or capacity reductions because of left-turning vehicles.

TWLTLs can reduce delays to through traffic, reduce rear-end accidents, and provide separation between opposing lanes of traffic. However, they do not provide refuge for pedestrians and can encourage strip development with additional closely spaced access points. Evaluate other alternatives (such as prohibiting midblock left turns and providing for U-turns) before using a TWLTL. (See Chapters 1140 and 540 for additional restrictions on the use of TWLTLs.)

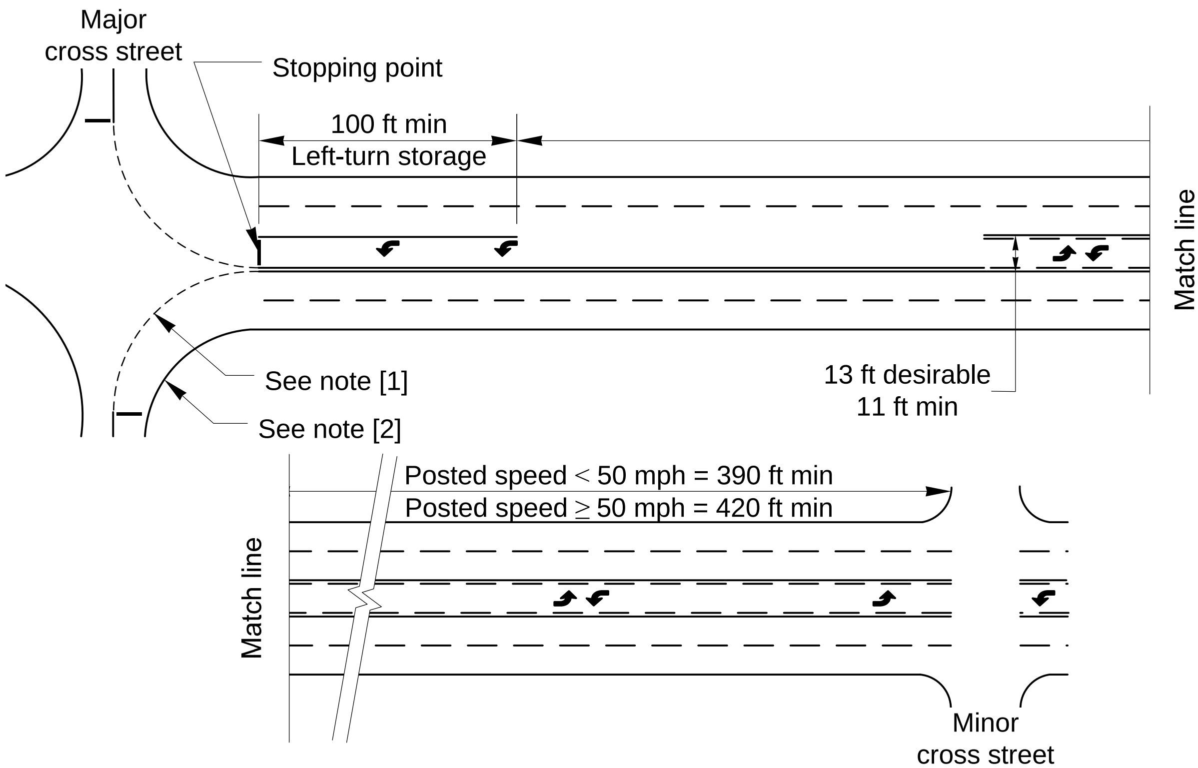
The basic design for a TWLTL is illustrated in Exhibit 1310-18f. Additional criteria are as follows:

- The desirable length of a TWLTL is not less than 250 feet.
- Provide illumination in accordance with the guidelines in Chapter 1040.
- Pavement markings, signs, and other traffic control devices must be in accordance with the MUTCD and the *Standard Plans*.
- Provide clear channelization when changing from TWLTLs to one-way left-turn lanes at an intersection.

(3) Right-Turn Lanes

Right-turn movements influence intersection capacity even though there is no conflict between right-turning vehicles and opposing traffic. Right-turn lanes might be needed to maintain efficient intersection operation. Use the following to determine when to provide right-turn lanes at unsignalized intersections:

- For two-lane roadways and for multilane roadways with a posted speed of 45 mph or above, when recommended by Exhibit 1310-19.
- An accident study indicates an overall accident reduction with a right-turn lane.
- The presence of pedestrians requires right-turning vehicles to stop.
- Restrictive geometrics require right-turning vehicles to slow greatly below the speed of the through traffic.
- There is less than decision sight distance for traffic approaching the intersection.



Notes:

[1] Desirable radius not less than 50 ft. Use templates to verify that the design vehicle can make the turn.

[2] For right-turn corner design, see Exhibit 1310-14.

General:

For pavement marking details and signing criteria, see the *Standard Plans* and the MUTCD.

Median Channelization: Two-Way Left-Turn Lane

Exhibit 1310-18f

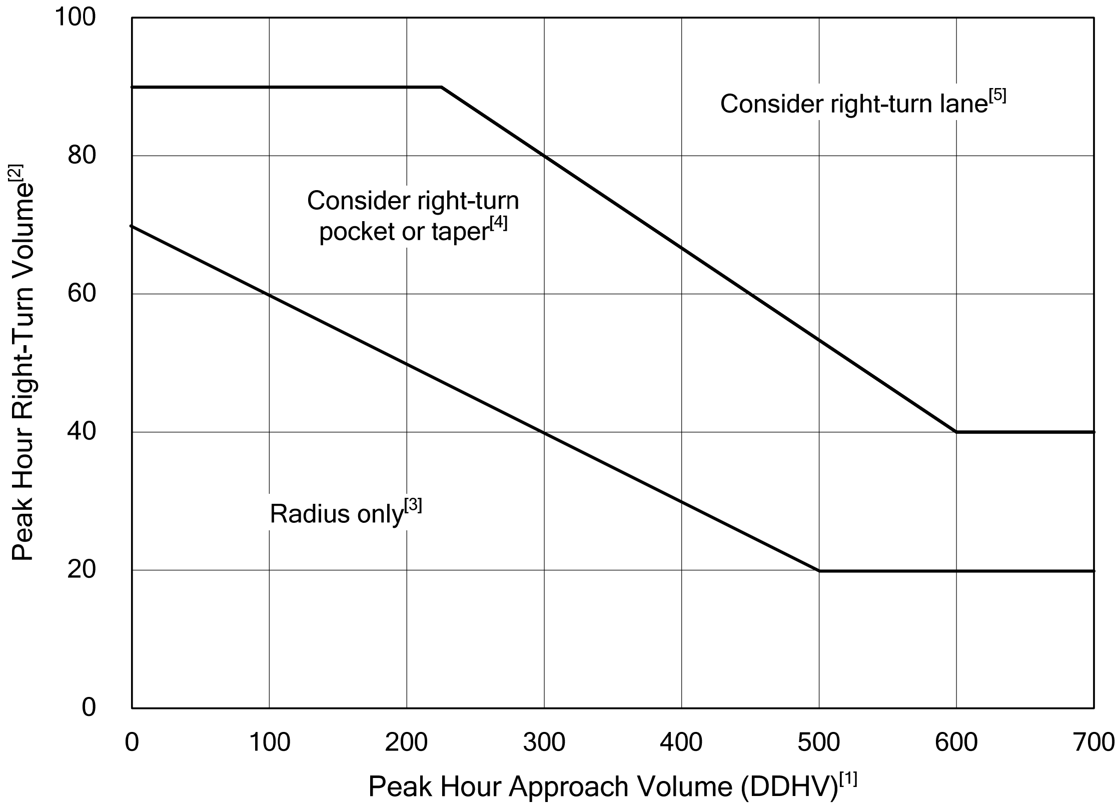
For unsignalized intersections, see 1310.07(4) for guidance on right-turn lane lengths. For signalized intersections, use a traffic signal analysis to determine whether a right-turn lane is needed and what the length is (see Chapter 1330).

A capacity analysis may be used to determine whether right-turn lanes are needed to maintain the desired level of service.

Where adequate right of way exists, providing right-turn lanes is relatively inexpensive and can provide increased operational efficiency.

The right-turn pocket or the right-turn taper (see Exhibit 1310-20) may be used at any minor intersection where a right-turn lane is not provided. These designs reduce interference and delay to the through movement by offering an earlier exit to right-turning vehicles.

If the right-turn pocket is used, Exhibit 1310-20 shows taper lengths for various posted speeds.



Notes:

[1] For two-lane highways, use the peak hour DDHV (through + right-turn).
For multilane, high-speed highways (posted speed 45 mph or above), use the right-lane peak hour approach volume (through + right-turn).

[2] When all three of the following conditions are met, reduce the right-turn DDHV by 20:
- The posted speed is 45 mph or below
- The right-turn volume is greater than 40 VPH
- The peak hour approach volume (DDHV) is less than 300 VPH

[3] For right-turn corner design, see Exhibit 1310-14.

[4] For right-turn pocket or taper design, see Exhibit 1310-20.

[5] For right-turn lane design, see Exhibit 1310-21.

General:
For additional guidance, see 1310.07(3).

Right-Turn Lane Guidelines[6]
Exhibit 1310-19

(4) Speed Change Lanes

A speed change lane is an auxiliary lane primarily for the acceleration or deceleration of vehicles entering or leaving the through traveled way. Speed change lanes are normally provided for at-grade intersections on multilane divided highways with access control. Where roadside conditions and right of way allow, speed change lanes may be provided on other through roadways. Justification for a speed change lane depends on many factors, including speed; traffic volumes; capacity; type of highway; design and frequency of intersections; and accident history.

A dedicated deceleration lane (see Exhibit 1310-21) is advantageous because it removes slowing vehicles from the through lane.

An acceleration lane (see Exhibit 1310-22) is not as advantageous because entering drivers can wait for an opportunity to merge without disrupting through traffic. However, acceleration lanes for left-turning vehicles provide a benefit by allowing the turn to be made in two movements.

When either deceleration or acceleration lanes are to be used, design them in accordance with Exhibits 1310-21 and 1310-22. When the design speed of the turning traffic is greater than 20 mph, design the speed change lane as a ramp in accordance with Chapter 1360. When a deceleration lane is used with a left-turn lane, add the deceleration length to the storage length.

(5) Drop Lanes

A lane may be dropped at an intersection with a turn-only lane or beyond the intersection. Do not allow a lane-reduction taper to cross an intersection or end less than 100 feet before an intersection. (See Chapter 1210 for lane reduction pavement transitions.)

When a lane is dropped beyond signalized intersections, provide a lane of sufficient length to allow smooth merging. For facilities with a posted speed of 45 mph or higher, use a minimum length of 1,500 feet. For facilities with a posted speed lower than 45 mph, provide a lane of sufficient length that the advanced lane reduction warning sign can be placed not less than 100 feet beyond the intersection area.

When a lane is dropped beyond unsignalized intersections, provide a lane beyond the intersection not less than the acceleration lane length from Exhibit 1310-22.

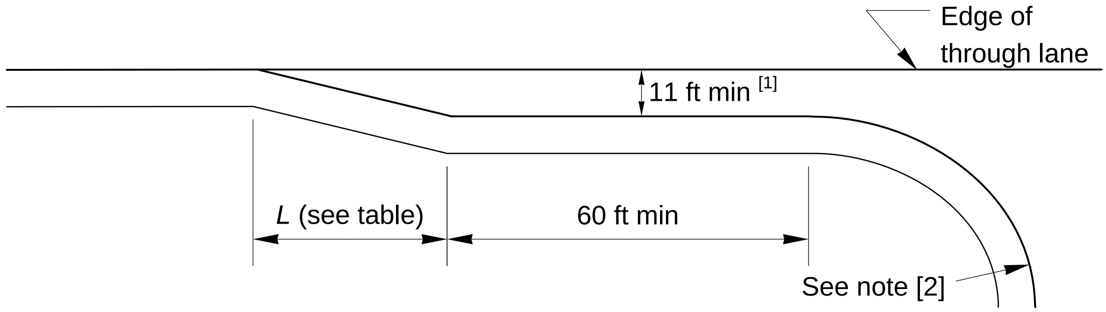
(6) Shoulders

With justification, shoulder widths may be reduced within areas channelized for intersection turning lanes or speed change lanes. Apply left shoulder width criteria to the median shoulder of divided highways. On one-way couplets, apply the width criteria for the right shoulder to both the right and left shoulders.

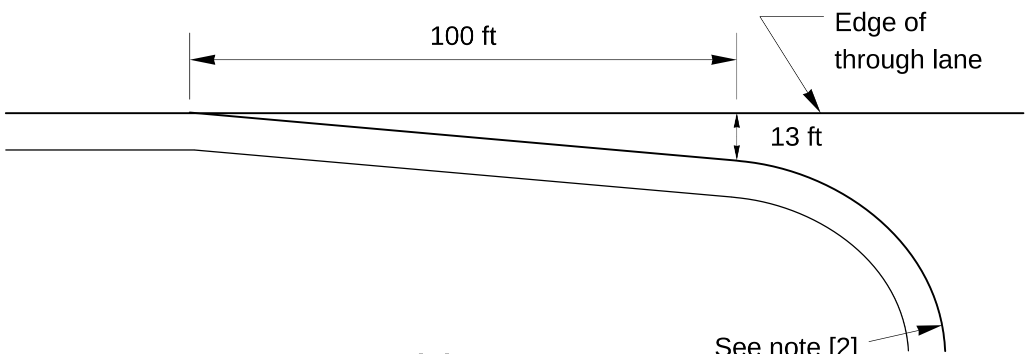
For roadways without curb sections, the shoulder adjacent to turn lanes and speed change lanes may be reduced to 2 feet on the left and 4 feet on the right. When a curb and sidewalk section is used with a turn lane or speed change lane 400 feet or less in length, the shoulder abutting the turn lane may be eliminated. In instances where curb is used without sidewalk, provide a minimum of 4-foot-wide shoulders on the right. Where curbing is used adjacent to left-turn lanes, the shoulder may be eliminated. Adjust the design of the intersection as needed to allow for vehicle tracking.

Reducing the shoulder width at intersections facilitates the installation of turn lanes without unduly affecting the overall width of the roadway. A narrower roadway also reduces pedestrian exposure in crosswalks and discourages motorists from using the shoulder to bypass other turning traffic.

On routes where provisions are made for bicycles, /continue the bicycle facility between the turn lane and the through lane. (See Chapter 1520 for information on bicycle facilities.)



Right-Turn Pocket



Right-Turn Taper

Posted Speed Limit	*L*
Below 40 mph	40 ft
40 mph or above	100 ft

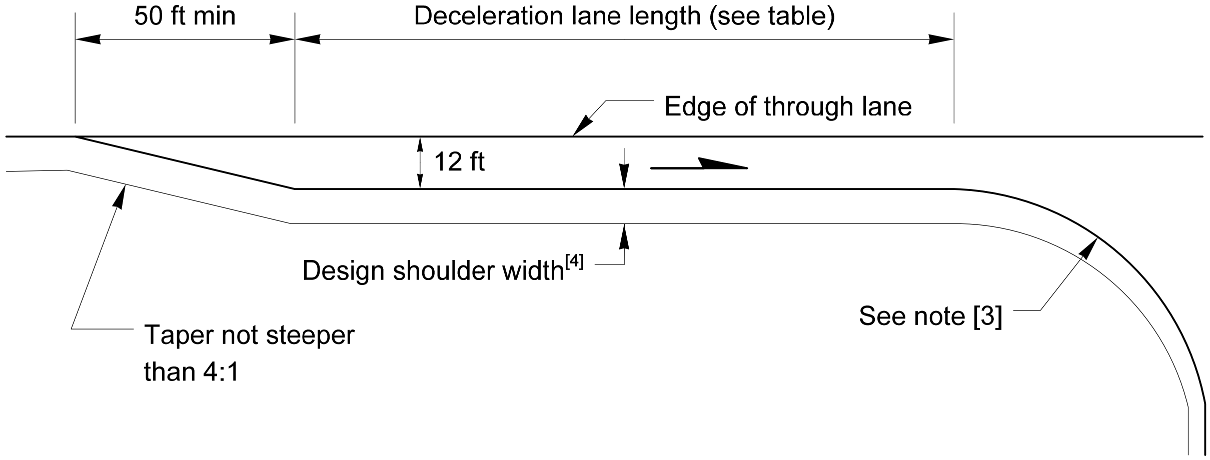
Notes:

[1] 12 ft desirable.

[2] For right-turn corner design, see Exhibit 1310-14.

Right-Turn Pocket and Right-Turn Taper

Exhibit 1310-20



Highway Design Speed (mph)	Turning Roadway Design Speed (mph)		
	Stop[1]	15	20
30	235	200[2]	170[2]
35	280	250	210
40	320	295	265
45	385	350	325
50	435	405	385
55	480	455	440
60	530	500	480
65	570	540	520
70	615	590	570

Minimum Deceleration Lane Length (ft)

Grade	Upgrade	Downgrade
3% to less than 5%	0.9	1.2
5% or more	0.8	1.35

Adjustment Multiplier for Grades 3% or Greater

Notes:

[1] For use when the turning traffic is likely to stop before completing the turn (for example, where pedestrians are present).

[2] When adjusting for grade, do not reduce the deceleration lane to less than 150 ft.

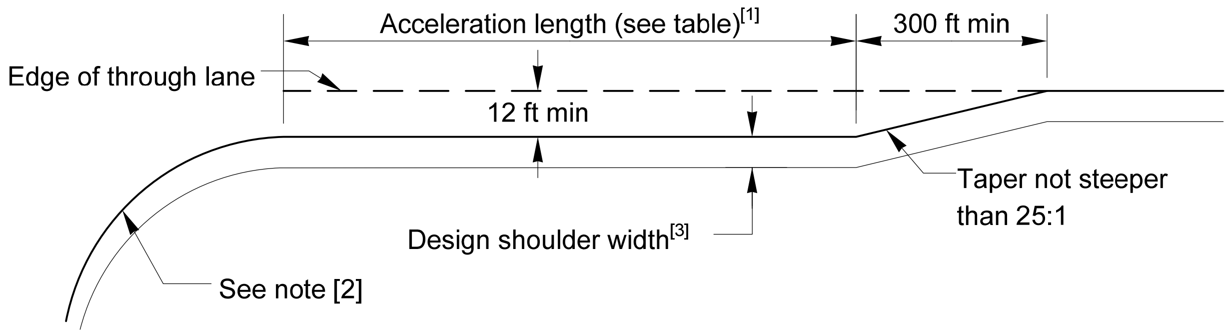
[3] For right-turn corner design, see Exhibit 1310-14.

[4] May be reduced (see 1310.07(6)).

General:

For pavement marking details, see the *Standard Plans* and the MUTCD.

Right-Turn Lane
Exhibit 1310-21



Highway Design Speed (mph)	Turning Roadway Design Speed (mph)		
	Stop	15	20
30	180	140	
35	280	220	160
40	360	300	270
45	560	490	440
50	720	660	610
55	960	900	810
60	1,200	1,140	1,100
65	1,410	1,350	1,310
70	1,620	1,560	1,520

Minimum Acceleration Lane Length (ft)[1]

Highway Design Speed (mph)	% Grade	Upgrade	Downgrade
40 50 60 70	3% to less than 5%	1.3 1.3 1.4 1.5	0.7 0.65 0.6 0.6
40 50 60 70	5% or more	1.5 1.5 1.7 2.0	0.6 0.55 0.5 0.5

Adjustment Multiplier for Grades 3% or Greater

Notes:

[1] At free right turns (no stop required) and all left turns, the minimum acceleration lane length is not less than 300 ft.

[2] For right-turn corner design, see Exhibit 1310-14.

[3] May be reduced (see 1310.07(6)).

General:

For pavement-marking details, see the *Standard Plans* and the MUTCD.

Acceleration Lane

Exhibit 1310-22

(7) Islands

An island is a defined area within an intersection between traffic lanes for the separation of vehicle movements or for pedestrian refuge. Within an intersection, a median is considered an island. Design islands to clearly delineate the traffic channels to drivers and pedestrians.

Traffic islands perform the following functions:

- Channelization islands control and direct traffic movements.
- Divisional islands separate traffic movements.
- Refuge islands provide refuge for pedestrians and bicyclists crossing the roadway.
- Islands can provide for the placement of traffic control devices and luminaires.
- Islands can provide areas within the roadway for landscaping.

(a) Size and Shape

Divisional islands are normally elongated and at least 4 feet wide and 20 feet long.

Channelization islands are normally triangular. In rural areas, 75 ft^2 is the minimum island area and 100 ft^2 is desirable. In urban areas where posted speeds are 25 mph or below, smaller islands are acceptable. Use islands with at least 200 ft^2 if pedestrians will be crossing or traffic control devices or luminaires will be installed.

Design triangular-shaped islands as shown in Exhibits 1310-23a through 23c. The shoulder and offset widths illustrated are for islands with vertical curbs 6 inches or higher. Where painted islands are used, such as in rural areas, these widths are desirable but may be omitted. (See Chapter 1240 for desirable turning roadway widths.)

Island markings may be supplemented with reflective raised pavement markers.

Provide barrier-free access at crosswalk locations where raised islands are used. For pedestrian refuge islands and barrier-free access requirements, see Chapter 1510.

(b) Location

Design the approach ends of islands so they are visible to motorists. Position the island so that a smooth transition in vehicle speed and direction is attained. Begin transverse lane shifts far enough in advance of the intersection to allow gradual transitions. Avoid introducing islands on a horizontal or vertical curve. If the use of an island on a curve cannot be avoided, provide sight distance, illumination, or extension of the island.

(c) Compound Right-Turn Lane

To design large islands, the common method is to use a large-radius curve for the turning traffic. While this does provide a larger island, it also encourages higher turning speeds. Where pedestrians are a concern, higher turning speeds are undesirable. An alternative is a compound curve with a large radius followed by a small radius (see Exhibit 1310-23b). This design forces the turning traffic to slow down.

(d) Curbing

Provide vertical curb 6 inches or higher for:

- Islands with luminaires, signals, or other traffic control devices.
- Pedestrian refuge islands.

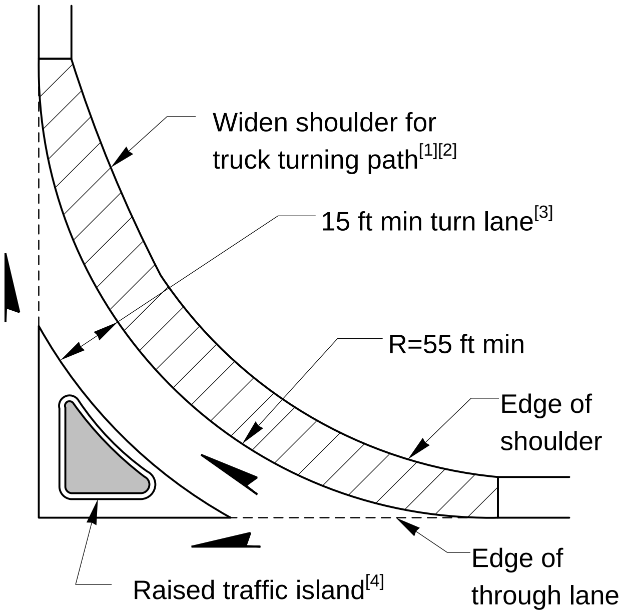
Also consider curbing for:

- Divisional and channelizing islands.
- Landscaped islands.

In general, except to meet one of the uses listed above, it is desirable not to use curbs on facilities with a posted speed of 45 mph or above.

Avoid using curbs if the same objective can be attained with pavement markings.

Refer to Chapter 1140 for additional information and design criteria on the use of curbs.



Small Traffic Island Design[5]

Notes:

[1] Widen shoulders when right-turn radii or roadway width cannot be provided for large trucks. Design widened shoulder pavement the same depth as the right-turn lane.

[2] Use the truck turning path templates for the design vehicle and a minimum 2-ft clearance between the wheel paths and the face of curb or edge of shoulder to determine the width of the widened shoulder.

[3] For desirable turning roadway widths, see Chapter 1240.

[4] For additional details on island placement, see Exhibit 1310-23c.

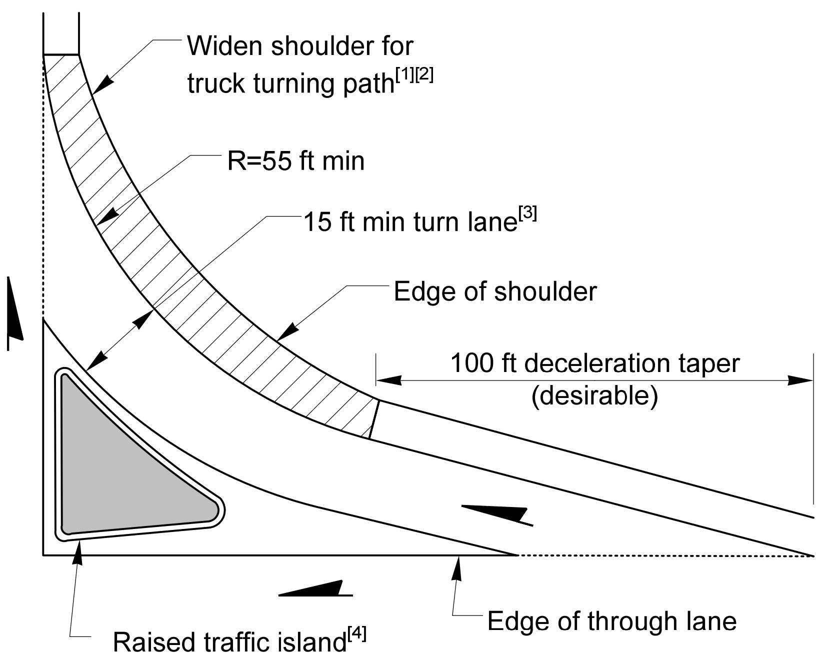
[5] Small traffic islands have an area of 100 ft^2 or less; large traffic islands have an area greater than 100 ft^2.

General:

Provide an accessible route for pedestrians (see Chapter 1510).

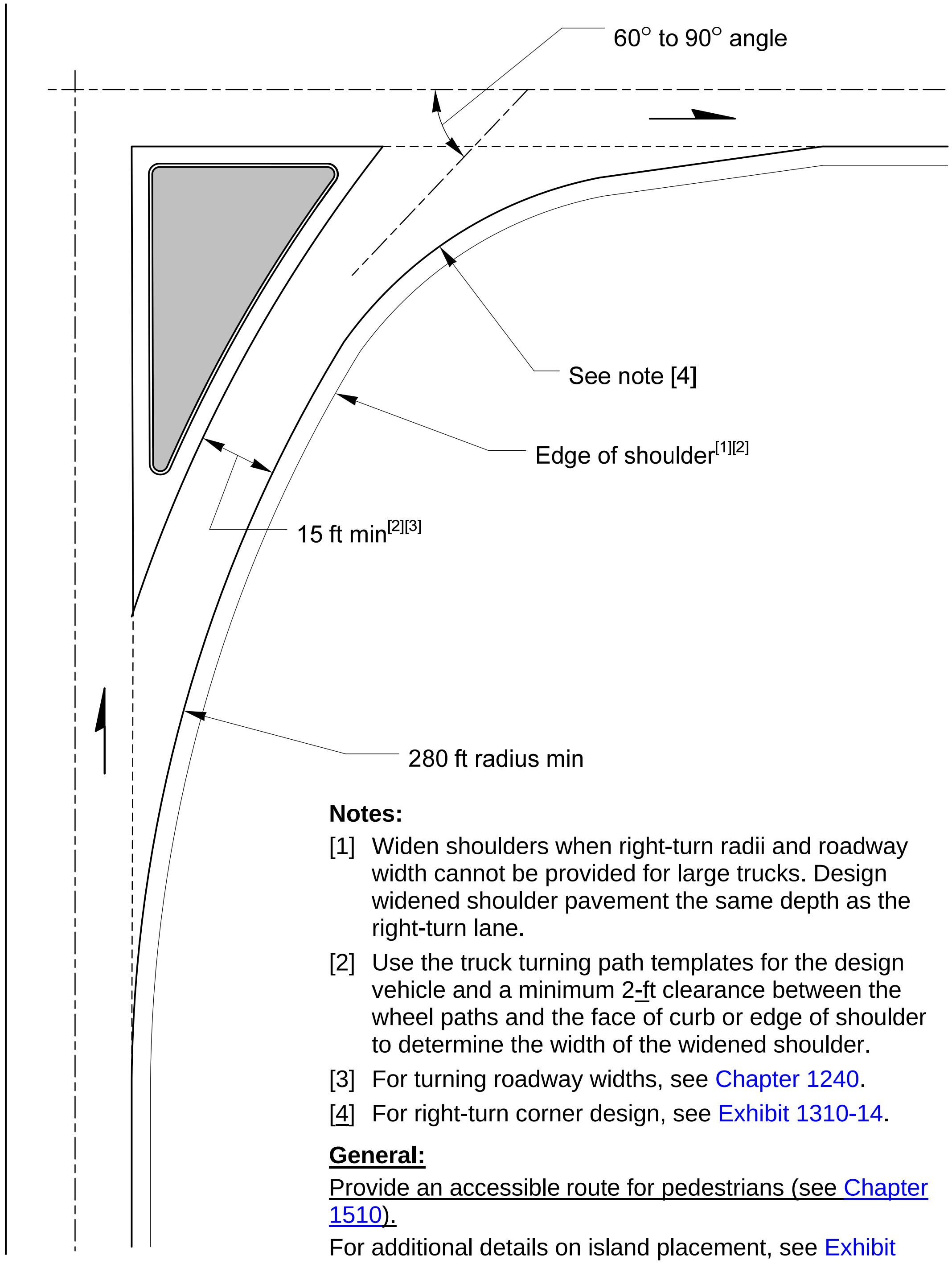
60° to 90° angle at stop or yield control.

For right-turn corner design, see Exhibit 1310-14.



Large Traffic Island Design[5]

Traffic Island Designs
Exhibit 1310-23a



Notes:

[1] Widen shoulders when right-turn radii and roadway width cannot be provided for large trucks. Design widened shoulder pavement the same depth as the right-turn lane.

[2] Use the truck turning path templates for the design vehicle and a minimum 2-ft clearance between the wheel paths and the face of curb or edge of shoulder to determine the width of the widened shoulder.

[3] For turning roadway widths, see Chapter 1240.

[4] For right-turn corner design, see Exhibit 1310-14.

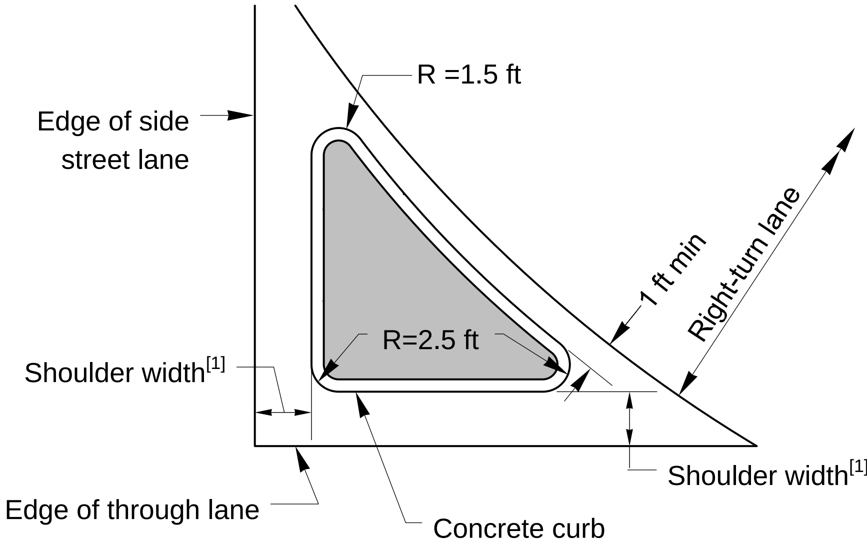
General:

Provide an accessible route for pedestrians (see Chapter 1510).

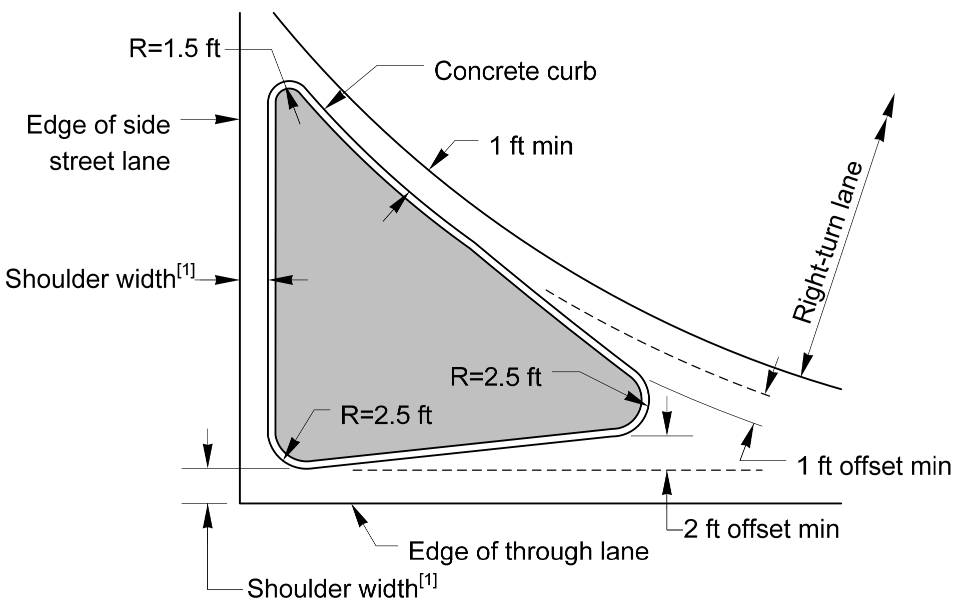
For additional details on island placement, see Exhibit 1310-23c.

Traffic Island Designs: Compound Curve

Exhibit 1310-23b



Small Raised Traffic Island[2]



Large Raised Traffic Island

Notes:

[1] For minimum shoulder width at curbs, see Chapter 1140. For additional information on shoulders at turn lanes, see 1310.07(6).

[2] Small traffic islands have an area of 100 ft^2 or less; large traffic islands have an area greater than 100 ft^2.

General:

Provide an accessible route for pedestrians (see Chapter 1510).

Traffic Island Designs
Exhibit 1310-23c

1310.08 U-Turns

For divided multilane highways without full access control that have access points where the median prevents left turns, evaluate the demand for locations that allow U-turns. Normally, U-turn opportunities are provided at intersections. However, where intersections are spaced far apart, U-turn median openings may be provided between intersections to accommodate U-turns. Use the desirable U-turn spacing (see Exhibit 1310-24) as a guide to determine when to provide U-turn median openings between intersections. Where the U-turning volumes are low, longer spacing may be used.

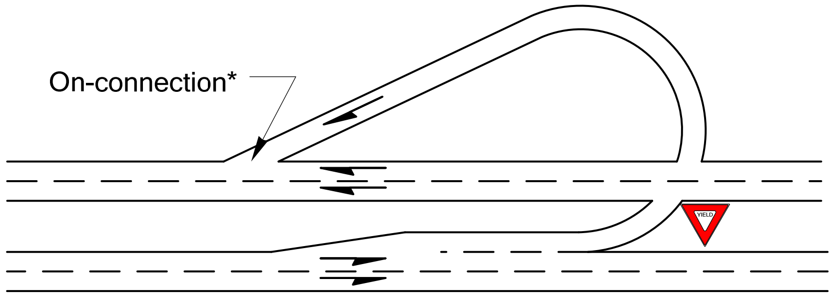
Locate U-turn median openings where intersection sight distance can be provided.

Urban/Rural	Desirable	Minimum
Urban[1]	1,000 ft	[2]
Suburban	½ mile	¼ mile[3]
Rural	1 mile	½ mile

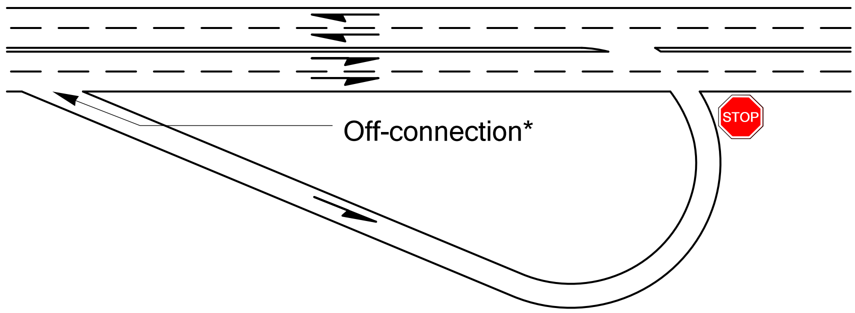
Notes:
[1] For design speeds higher than 45 mph, use suburban spacing.
[2] The minimum spacing is the acceleration lane length from a stop (see Exhibit 1310-22) plus 300 ft.
[3] For design speeds 60 mph or higher, the minimum spacing is the acceleration lane length from a stop (see Exhibit 1310-22) plus 300 ft.

U-Turn Spacing
Exhibit 1310-24

When designing U-turn median openings, use Exhibit 1310-26 as a guide. Where the median is less than 40 feet wide with a large design vehicle, provide a U-turn roadway (see Exhibit 1310-25). Design A, with the U-turn roadway after the left-turn, is desirable. Use Design A when the median can accommodate a left-turn lane. Use Design B only where left-turn channelization cannot be built in the median.



Design A



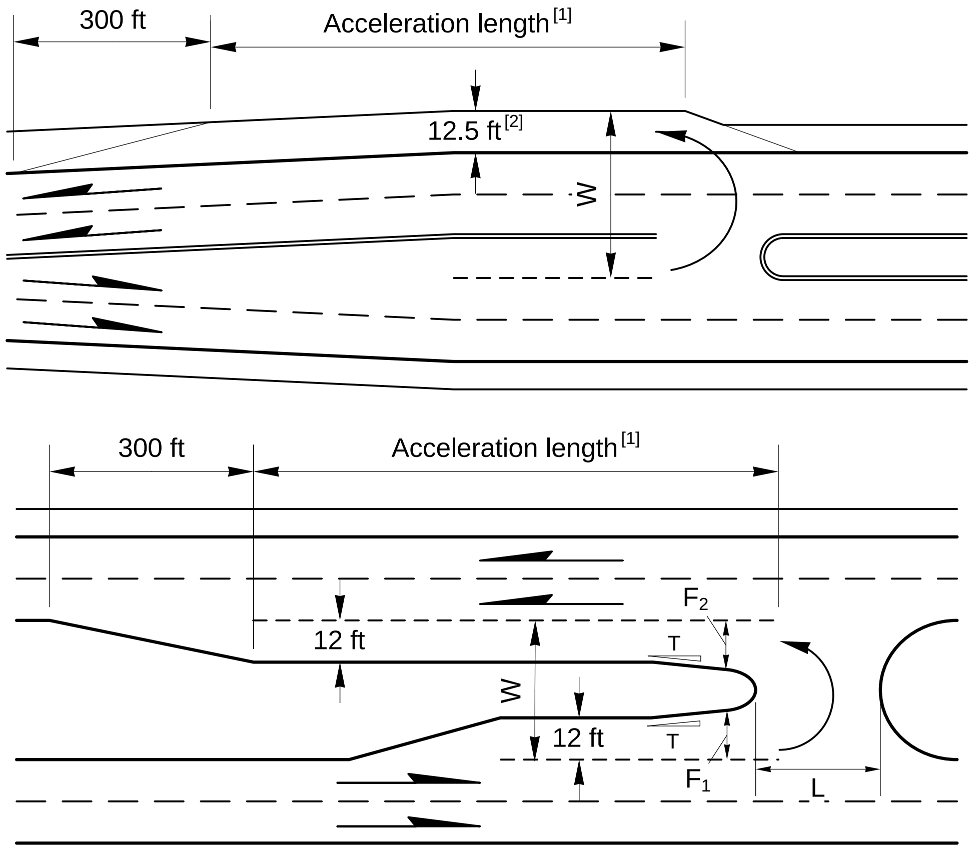
Design B

*Design on- and off-connections in accordance with Chapter 1360.

U-Turn Roadway
Exhibit 1310-25

Document the need for U-turn locations and the spacing used, and justify the selected design vehicle. If the design vehicle is smaller than the largest vehicle using the facility, provide an alternate route.

U-turns at signal-controlled intersections do not need the acceleration lanes shown in Exhibit 1310-26. For new U-turn locations at signal-controlled intersections, evaluate conflicts between right-turning vehicles from side streets and U-turning vehicles. Warning signs on the cross street might be appropriate.



Vehicle	W	R	L	F_1	F_2	T
P	52	14	14	12	12	—
SU	87	30	20	13	15	10:1
BUS	87	28	23	14	18	10:1
WB-40	84	25	27	15	20	6:1
WB-50	94	26	31	16	25	6:1
WB-67	94	22	49	15	35	6:1
MH	84	27	20	15	16	10:1
P/T	52	11	13	12	18	6:1
MH/B	103	36	22	15	16	10:1

U-Turn Design Dimensions

Notes:

[1] The minimum length of the acceleration lane is shown in Exhibit 1310-22. Acceleration lane may be eliminated at signal-controlled intersections.

[2] When U-turn uses the shoulder, provide 12.5-ft shoulder width and shoulder pavement designed to the same depth as the through lanes for the acceleration length and taper.

General:

All dimensions are in feet.

U-Turn Median Openings
Exhibit 1310-26

1310.09 Intersection Sight Distance

Providing drivers the ability to see stop signs, traffic signals, and oncoming traffic in time to react accordingly will reduce the probability of conflicts occurring at an intersection. Actually avoiding conflicts is dependent on the judgment, abilities, and actions of all drivers using the intersection.

Provide decision sight distance, where feasible, in advance of stop signs, traffic signals, and roundabouts. (See Chapter 1260 for guidance.)

The driver of a vehicle that is stopped and waiting to cross or enter a through roadway needs obstruction-free sight triangles in order to see enough of the through roadway to complete all legal maneuvers before an approaching vehicle on the through roadway can reach the intersection. Use Exhibit 1310-27a to determine minimum sight distance along the through roadway.

The sight triangle is determined as shown in Exhibit 1310-27b. Within the sight triangle, lay back the cut slopes and remove, lower, or move hedges, trees, signs, utility poles, signal poles, and anything else large enough to be a sight obstruction. Eliminate parking to remove obstructions to sight distance. In order to maintain the sight distance, the sight triangle must be within the right of way or a state maintenance easement (see Chapter 510).

The minimum setback distance for the sight triangle is 18 feet from the edge of traveled way. This is for a vehicle stopped 10 feet from the edge of traveled way. The driver is almost always 8 feet or less from the front of the vehicle; therefore, 8 feet are added to the setback. When the stop bar is placed more than 10 feet from the edge of traveled way, providing the sight triangle to a point 8 feet back of the stop bar is desirable.

Provide a clear sight triangle for a P vehicle at all intersections. In addition, provide a clear sight triangle for the SU vehicle for rural highway conditions. If there is significant combination truck traffic, use the WB-50 or WB-67 rather than the SU. In areas where SU or WB vehicles are minimal and right of way restrictions limit sight triangle clearing, only the P vehicle sight distance needs to be provided.

At existing intersections, when sight obstructions within the sight triangle cannot be removed due to limited right of way, the intersection sight distance may be modified. Drivers who do not have the desired sight distance creep out until the sight distance is available; therefore, the setback may be reduced to 10 feet. Document the right of way width and provide a brief analysis of the intersection sight distance clarifying the reasons for reduction. Verify and document that there is no identified collision trend at the intersection. Document the intersection location and the available sight distance in the Design Variance Inventory (see Chapter 300) as a design exception.

If the intersection sight distance cannot be provided using the reductions in the preceding paragraph, where stopping sight distance is provided for the major roadway, the intersection sight distance, at the 10-foot setback point, may be reduced to the stopping sight distance for the major roadway, with an evaluate upgrade and HQ Design Office review and concurrence. (See Chapter 1260 for required stopping sight distance.) Document the right of way width and provide a brief analysis of the intersection sight distance clarifying the reasons for reduction. Verify and document that there is no identified collision trend at the intersection. Document the intersection location and the available sight distance in the Design Variance Inventory (see Chapter 300) as an evaluate upgrade.

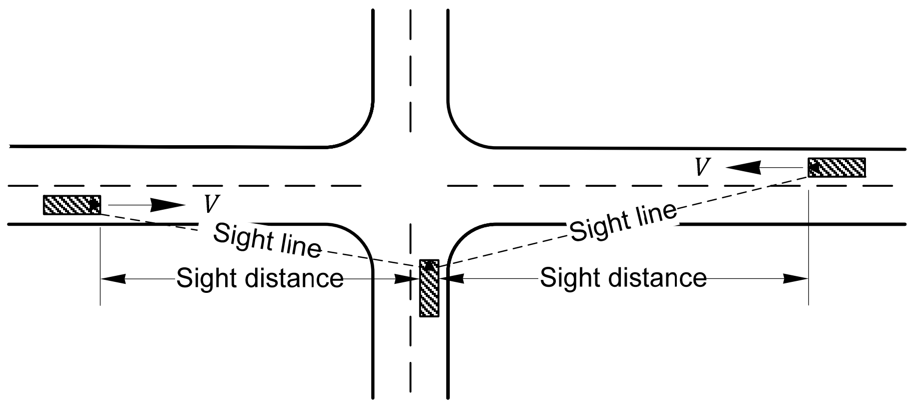
In some instances, intersection sight distance is provided at the time of construction, but subsequent vegetative growth has degraded the sight distance available. The growth may be seasonal or occur over time. In these instances, intersection sight distance can be restored through the periodically scheduled maintenance of vegetation in the sight triangle within the WSDOT right of way or state maintenance easement.

At intersections controlled by traffic signals, provide sight distance for right-turning vehicles.

Designs for movements that cross divided highways are influenced by median widths. If the median is wide enough to store the design vehicle, with a 3-foot clearance at both ends of the vehicle, sight distances are determined in two steps. The first step is for crossing from a stopped position to the median storage. The second step is for the movement, either across or left into the through roadway.

Design sight distance for ramp terminals as at-grade intersections with only left- and right-turning movements. An added element at ramp terminals is the grade separation structure. Exhibit 1310-27b gives the sight distance guidance in the vicinity of a structure. In addition, when the crossroad is an undercrossing, check the sight distance under the structure graphically using a truck eye height of 6 feet and an object height of 1.5 feet.

Document a brief description of the intersection area, sight distance restrictions, and traffic characteristics to support the design vehicle and sight distances chosen.



$S_i = 1.47Vt_g$
Where: S_i = Intersection sight distance (ft) V = Design speed of the through roadway (mph) t_g = Time gap for the minor roadway traffic to enter or cross the through roadway (sec)

Intersection Sight Distance Equation
Table 1

Design Vehicle	Time Gap (t_g) in Sec
Passenger car (P)	7.5
Single-unit trucks and buses (SU & BUS)	9.5
Combination trucks (WB-40, WB-50, & WB-67)	11.5
Note: Values are for a stopped vehicle to turn left onto a two-lane two-way roadway with no median and grades 3% or less.	

Intersection Sight Distance Gap Times (t_g)
Table 2

Adjust the t_g values listed in Table 2 as follows:

Crossing or right-turn maneuvers:

All vehicles	subtract 1.0 sec

Multilane roadways:

Left turns, for each lane in excess of one to be crossed, and for medians wider than 4 ft:

Passenger cars	add 0.5 sec
All trucks and buses	add 0.7 sec

Crossing maneuvers, for each lane in excess of two to be crossed, and for medians wider than 4 ft:

Passenger cars	add 0.5 sec
All trucks and buses	add 0.7 sec

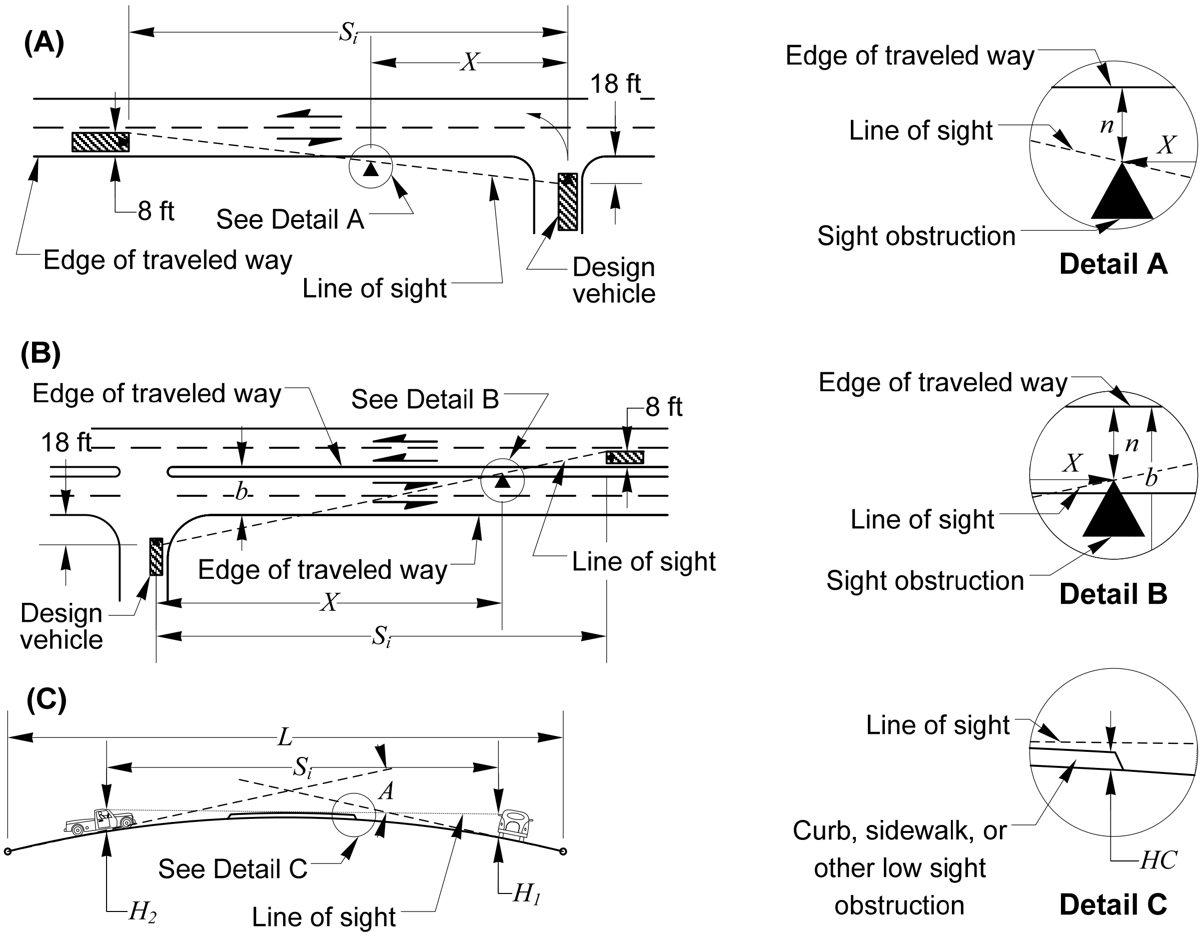
Note: Where medians are wide enough to store the design vehicle, determine the sight distance as two maneuvers.

Crossroad grade greater than 3%:

All movements upgrade for each percent that exceeds 3%:

All vehicles	add 0.2 sec

Sight Distance at Intersections
Exhibit 1310-27a



For sight obstruction driver cannot see over:

$$S_i = \frac{(26+b)(X)}{(18+b+n)}$$

Where:

- S_i = Available intersection sight distance (ft)
- n = Offset from sight obstruction to edge of lane (ft)
- b = Distance from near edge of traveled way to near edge of lane approaching from right (ft) (b=0 for sight distance to the left)
- X = Distance from centerline of lane to sight obstruction (ft)

For crest vertical curve over a low sight obstruction when S<L:

$$S_i = \sqrt{\frac{100L\left[\sqrt{2(H_1 - HC)} + \sqrt{2(H_2 - HC)}\right]^2}{A}}$$

$$L = \frac{AS_i^2}{100\left[\sqrt{2(H_1 - HC)} + \sqrt{2(h_2 - HC)}\right]^2}$$

Where:

- $S\underline{i}$ = Available sight distance (ft)
- H_1 = Eye height (3.5 ft for passenger cars; 6 ft for all trucks)
- H_2 = Object height (3.5 ft)
- HC = Sight obstruction height (ft)
- L = Vertical curve length (ft).
- A = Algebraic difference in grades (%)

Sight Distance at Intersections
Exhibit 1310-27b

1310.10 Traffic Control at Intersections

Intersection traffic control is the process of moving traffic through areas of potential conflict where two or more roadways meet. Signs, signals, channelization, and physical layout are the major tools used to establish intersection control.

(1) Intersection Traffic Control Objectives

There are three objectives to intersection traffic control that can greatly improve intersection operations.

(a) Maximize Intersection Capacity

Since two or more traffic streams cross, converge, or diverge at intersections, the capacity of an intersection is normally less than the roadway between intersections. It is usually necessary to assign right of way through the use of traffic control devices to maximize capacity for all users of the intersection. Turn prohibitions may be used to increase intersection capacity.

(b) Reduce Conflict Points

The crossing, converging, and diverging of traffic creates conflicts that increase the potential for accidents. Establishing appropriate controls can reduce the possibility of two cars attempting to occupy the same space at the same time. Pedestrian accident potential can also be reduced by appropriate controls.

(c) Prioritize Major Street Traffic

Traffic on major routes is normally given the right of way over traffic on minor streets to increase intersection operational efficiency. If a signal is being considered or exists at an intersection that is to be modified, provide a preliminary signal plan (see Chapter 1330). If a new signal permit is required, obtain approval before the design is approved.

(2) Analysis of Alternatives

<u>Prior to proceeding with the design, p</u>rovide an analysis of alternatives for a proposal to install a traffic signal or a roundabout on a state route, either NHS or Non-NHS, <u>with a posted speed limit of 45 mph or higher,</u> approved by the region Traffic Engineer, with review and comment by the HQ Design Office. Include the following alternatives in the analysis:

- Channelization: deceleration lanes, storage, and acceleration lanes for left- and right-turning traffic.
- Right-off/right-on with U-turn opportunities.
- Grade separation.
- Roundabouts.
- Traffic control signals.

Include a copy of the analysis with the preliminary signal plan or roundabout justification.

1310.11 Signing and Delineation

Use the MUTCD and the *Standard Plans* for signing and delineation criteria. Provide a route confirmation sign on all state routes shortly after major intersections. (See Chapter 1020 for additional information on signing.)

Painted or plastic pavement markings are normally used to delineate travel paths. For pavement marking details, see the MUTCD, Chapter 1030, and the *Standard Plans*.

Contact the region or HQ Traffic Office for additional information when designing signing and pavement markings.

1310.12 Procedures

Document design decisions and conclusions in accordance with Chapter 300. For highways with limited access control, see Chapter 530.

(1) Approval

An intersection is approved in accordance with Chapter 300. Complete the following items, as needed, before intersection approval:

- Traffic analysis
- Deviations approved in accordance with Chapter 300
- Approved Traffic Signal Permit (DOT Form 242-014 EF) (see Chapter 1330)

(2) Intersection Plans

Provide intersection plans for any increases in capacity (turn lanes) at an intersection, modification of channelization, or change of intersection geometrics. Support the need for intersection or channelization modifications with history; school bus and mail route studies; hazardous materials route studies; pedestrian use; public meeting comments; and so forth.

For information to be included on the intersection plan for approval, see the Intersection/Channelization Plan for Approval Checklist on the following website:
www.wsdot.wa.gov/design/projectdev/

(3) Local Agency or Developer-Initiated Intersections

There is a separate procedure for local agency or developer-initiated projects at intersections with state routes. The project initiator submits an intersection plan and the documentation of design decisions that led to the plan to the region for approval. For those plans requiring a design variance, the deviation or evaluate upgrade must be approved in accordance with Chapter 300 prior to approval of the plan. After the plan approval, the region prepares a construction agreement with the project initiator (see the *Utilities Manual*).

1310.13 Documentation

For the list of documents required to be preserved in the Design Documentation Package and the Project File, see the Design Documentation Checklist:
www.wsdot.wa.gov/design/projectdev/

1320.11 Access, Parking, and Transit Facilities

No road approach connections to the circulating roadway are allowed at roundabouts unless they are designed as legs to the roundabout. It is desirable that road approaches not be located on the approach or departure legs within the length of the splitter island. The minimum distance from the circulating roadway to a road approach is controlled by corner clearance using the outside edge of the circulating roadway as the crossroad (see Chapter 540). If minimum corner clearance cannot be met, provide justification. (For additional information on limited access highways, see Chapter 530.)

If the parcel adjoins two legs of the roundabout, it is acceptable to provide a right-in/right-out driveway within the length of the splitter islands on both legs. This provides for all movements; design both driveways to accommodate their design vehicles (see Exhibit 1320-33a).

Roadways between roundabouts may have restrictive medians with left-turn access provided with U-turns at the roundabouts (see Exhibit 1320-33b).

Parking is not allowed in the circulating roadway or on the entry or exit roadway within the length of the splitter island.

Transit stops are not allowed in the circulating roadway, in the approach lanes within the length of the splitter island, or in the exit lanes prior to the crosswalk. Locate transit stops on the roadway before or after the roundabout, in a pullout or where the pavement is wide enough that a stopped bus does not block the through movement of traffic or impede sight distance.

1320.12 Design Procedures

Document roundabout design considerations and conclusions in accordance with Chapter 300.

(1) Conceptual Design

Early coordination between the design team, region Traffic and Project Development offices, and HQ Traffic and Design offices is essential for a roundabout design layout.

(a) Conceptual Meeting

Conduct a Conceptual Meeting with the region Traffic Office, the region Project Development Engineer or Engineering Manager, and the HQ Traffic and Design offices after the traffic analysis has been completed. The intent of this meeting is to review, discuss, and evaluate alternative layouts for a roundabout before too much time and resources have been expended. The outcome of the meeting will provide sufficient information that a designer can proceed with finalizing the geometric design.

As a minimum, consider, discuss, and document the following items for the Conceptual Meeting:

1. **Project Overview**
2. **Traffic Analysis Recommendations and Conclusions**

   In addition to Chapter 320, Traffic Analysis, the following items need to be documented:

   - Use 20 years after the year construction is scheduled to begin as the design year of the analysis.
   - Identify the approximate year a single-lane roundabout intersection level of service (LOS) will operate below the selected design LOS or require expansion.
   - Identify and justify growth rate(s) used for the design year analysis.
   - Provide peak hour (both a.m. and p.m.) turning movement volumes for each leg for the existing and design year.
   - Input an environmental factor of 1.1 if required by the analysis software.
   - Provide pertinent reports generated (such as level of service, queue length, delay, percent stopped, and degree of saturation) from the analysis software used. (Contact the region or HQ Traffic Office for currently approved capacity analysis software. Using older software versions is not acceptable).
   - Provide explanation of the impacts to traffic operations upstream and downstream of the intersection in situations where V/C exceeds 0.92.

3. **Preliminary Layout**

   Provide an existing plan sheet, base map, or aerial photo (non-CADD-generated is encouraged) with the preliminary roundabout sketched at the intersection for use in evaluating current or new concepts to the roundabout layout. The intent is for the designer to quickly develop the roundabout footprint for the intersection without expending a lot of time or resources drafting PS&E-quality plans to show the design of the roundabout. Typically, revisions are needed based upon the feedback received at the Conceptual Meeting.

   Use an existing plan sheet, base map, or aerial photo of sufficient scale to show existing roadway alignment and features, surrounding topographic information (may include aboveground and belowground utility elements), rights of way (existing), surrounding buildings, environmental constraints (such as wetlands), drainage, and other constraints that may impact the design of the roundabout.

4. **Design Vehicle**

   Identify the design vehicle for each leg of the intersection. Include the truck types and sizes (oversized vehicles) that travel through the area (currently and in the future) and whether the roundabout is on an existing or planned truck route.

- The minimum size conduit for installations under a roadway at all other locations is 2 inches.

A 2-inch spare conduit is to be installed for all conduit crossings outside the core of the intersection. A 3-inch spare conduit is to be installed for all conduit crossings around the intersection perimeter. At least one 3-inch spare conduit is to be installed from the controller to the adjacent junction box to provide for future capacity. Size all conduits to provide 26% maximum conductor fill for new signal installations. A 40% fill area can be used when installing conductors in existing conduits. (See Exhibit 1330-13 for conduit and signal conductor sizes.)

Conduit Sizing Table			
Trade Size	Inside Diam. (inches)	Maximum Fill (inch^2)	
		26%	40%
1/2"	0.632	0.08	0.13
3/4"	0.836	0.14	0.22
1”	1.063	0.23	0.35
1 1/4"	1.394	0.40	0.61
1 1/2"	1.624	0.54	0.83
2”	2.083	0.89	1.36
2 1/2"	2.489	1.27	1.95
3”	3.09	1.95	3.00
3 1/2"	3.57	2.60	4.00
4”	4.05	3.35	5.15

Conductor Size Table			
Size (AWG)	Area (inch^2)	Size (AWG)	Area (inch^2)
# 14 USE	0.021	2cs (# 14)	0.090
# 12 USE	0.026	3cs (# 20)	0.070
# 10 USE	0.033	4cs (# 18)	0.060
# 8 USE	0.056	5c (# 14)	0.140
# 6 USE	0.073	7c (# 14)	0.170
# 4 USE	0.097	10c (# 14)	0.290
# 3 USE	0.113	6pcc (# 19)	0.320
# 2 USE	0.133		

Conduit and Conductor Sizes
Exhibit 1330-13

(d) **Electrical Service and Other Components**

Refer to Chapter 1040 for electrical service types, overcurrent protection, and descriptions and requirements for other components.

(e) **Roadway Conduit Crossings**

Minimize roadway crossings whenever possible; usually only three crossings are needed for a four-leg intersection and only two roadway crossings are needed for a T intersection. In most cases, the conduit should cross both the main line and side street from the corner where the controller is located. Directional boring is the method of choice when crossing the state route (main line). One main line crossing is usually sufficient; open cut trenching is acceptable on minor approaches. Open cut trenching to install conduits is allowed on existing roadways where substantial obstacles under the roadway will be encountered or where there is insufficient room for jacking or boring pits at the edges of the roadway. Open cut trenching is not permitted across limited access roadways unless the entire pavement surface is being replaced. Do not use sign or signal bridges for roadway crossings.

(12) Signal Design and Operation Near Railroad Crossings

If railroad tracks are within 500 feet of a signalized intersection, then a Railroad Crossing Evaluation Team is formed to determine the need (if any) for railroad preemption, interconnection, simultaneous preemption, advanced preemption, and so on. The Railroad Crossing Evaluation Team should consist of region and HQ Signal Design Engineers, region and HQ Signal Operations Engineers, HQ Railroad Liaison, region Utilities Engineer, region Traffic Design Engineer, region Maintenance Superintendent, and the affected railroad representative.

The Railroad Crossing Evaluation Team will determine what design considerations are needed at all signalized intersections near railroad crossings. A memo with each team member's concurrence with the PS&E documents is required for the DDP and is to be preserved as noted in 1330.07, Documentation. If railroad tracks are located within ¼ mile and are in excess of 500 feet from a signalized intersection, the same procedure will apply unless the region can demonstrate that 95% maximum queue lengths will not extend to within an area 200 feet from the tracks. Such demonstration is to be documented in the DDP and approved by the Railroad Crossing Evaluation Team.

The Railroad Crossing Evaluation Team has final review and approval authority for all PS&E documents for signal design and operation at all signalized intersections near railroad crossings.

Railroad preemption and interconnection are recommended when any of the following conditions occurs:

- The distance from the stop bar to the nearest rail is less than or equal to 200 feet.
- The 95% maximum queue lengths from the intersection stop bar are projected to cross the tracks. (Use a queue arrival/departure study or a traffic analysis "micro-simulation model" to determine 95% maximum queue lengths.)

Chapter 1350 Railroad Grade Crossings

1350.01 General

Highway-rail grade crossings ("grade crossings") are the intersection of two modes of transportation with very different physical and operational characteristics. Because of the inherent limitations associated with train operations, RCW 46.61.350 gives train traffic the right of way at grade crossings, thereby assigning motorists the primary responsibility to avoid collisions.

There are many variables that influence a motorist's ability to react appropriately at grade crossings, including what information is available to them as they approach the crossing and human factors such as competing decisions, distractions, and impaired driving. Primary factors to consider in the design of grade crossings are roadway and railway geometry; available sight distance; highway and railway speeds; competing decisions or visual distractions; and the types of warning devices at the grade crossing.

Another aspect of grade crossing design is coordination of highway traffic signal operations with grade crossing active warning devices ("railroad preemption") when signalized intersections are located near grade crossings. In such instances, railroad preemption is designed to clear the tracks of any vehicles that may be stopped as a result of the highway traffic signal when a train is approaching the grade crossing. Further guidance on railroad preemption requirements is provided in Chapter 1330.

Grade crossings are also unique due to their multijurisdictional nature. Highway authorities and railroad companies are each legally responsible for different elements at grade crossings. Additionally, the Washington Utilities and Transportation Commission (WUTC) is the state regulatory agency with oversight of public grade crossings in Washington, except within the limits of first class cities in accordance with RCW 81.53.240. Establishing new crossings, altering existing crossings, or closing crossings all require WUTC approval. Therefore, highway projects that include a grade crossing will generally require close coordination with both the railroad company and the WUTC.

Projects that include grade crossings will generally require execution of construction and maintenance agreements between the Washington State Department of Transportation (WSDOT) and the railroad company. These agreements specify the design elements of the crossing, work that the railroad will perform on behalf of the project, payment terms, and legal provisions. It may also be necessary for WSDOT to obtain easements from the railroad company for new grade crossings on railroad property. The Headquarters (HQ) Railroad Liaison is responsible for facilitating highway project coordination with railroad companies, including developing agreements and obtaining WUTC approvals. Obtaining necessary approvals from the railroad company may take several months. Contact the HQ Railroad Liaison early in the design phase so that all necessary design and agreement coordination can be completed according to project schedules.

More information about general railroad coordination and WUTC requirements is provided in Chapter 3 of the *Utilities Manual*.

1350.02 References

(1) Federal/State Laws and Codes

Revised Code of Washington (RCW) 81.53, Railroad crossings
http://apps.leg.wa.gov/rcw/default.aspx?cite=81.53

Washington Administrative Code (WAC) 480-62-150, Grade crossing petitions
http://apps.leg.wa.gov/wac/default.aspx?cite=480-62-150

(2) Design Guidance

Agreements Manual, M 22-99, WSDOT
http://wwwi.wsdot.wa.gov/publications/manuals/m22-99.htm

Manual on Uniform Traffic Control Devices for Streets and Highways, USDOT, FHWA; as adopted and modified by Chapter 468-95 WAC "Manual on uniform traffic control devices for streets and highways" (MUTCD)
www.wsdot.wa.gov/publications/manuals/mutcd.htm

Standard Plans for Road, Bridge, and Municipal Construction (Standard Plans), M 21-01, WSDOT
www.wsdot.wa.gov/publications/manuals/m21-01.htm

(3) Supporting Information

A Policy on Geometric Design of Highways and Streets (Green Book), AASHTO, 2004

Guidance On Traffic Control Devices At Highway-Rail Grade Crossings, Highway/Rail Grade Crossing Technical Working Group (TWG), FHWA, November 2002
safety.fhwa.dot.gov/media/twgreport.htm#2

Railroad-Highway Grade Crossing Handbook, FHWA, TS-86-215
http://www.fhwa.dot.gov/tfhrc/safety/pubs/86215/intro.htm

Traffic Control Devices Handbook, ITE, 2001
http://findarticles.com/p/articles/mi_qa3734/is_200407/ai_n9412867/

1350.03 Plans

(1) Proposed Improvements

Include plans for proposed improvements to existing crossings and any new crossings in the Plans, Specifications, and Estimates (PS&E) package. In addition to basic roadway dimensions, signs, and markings, indicate the angle of crossing; number of tracks; location of signals and other railway facilities (such as electrical/communications lines and control boxes); and the limits of property ownership by the railroad company at the crossing location.

For any project proposing to alter the horizontal or vertical alignment at a grade crossing, including grade separations, show the alignment and profile for both the railroad and the roadway for a minimum of 500 feet on all legs of the crossing. Show all other important features that might affect the safety, operation, and design of the crossing, such as nearby crossroads, driveways/entrances, buildings, and highway structures on the plans.

(a) Sight Distance

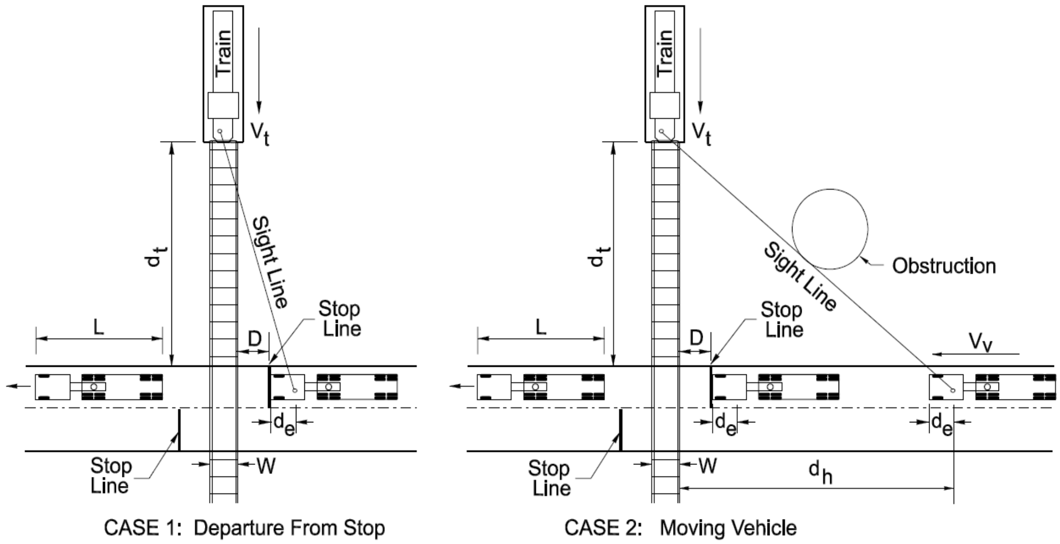
Sight distance is a primary consideration at railroad grade crossings. A railroad grade crossing is comparable to the intersection of two highways where a sight triangle is kept clear of obstructions or it is protected by a traffic control device. The desirable sight distance allows a driver to see an approaching train at a distance that allows the vehicle to stop well in advance of the crossing if signals, or gates and signals, are not present (see Exhibit 1350-1, Case 2). Sight distances of the order shown are desirable at any railroad grade crossing not controlled by railroad flashing light signals or gates (active warning devices). Attainment of optimal sight distances is often difficult and impracticable due to topography and terrain. Even in flat, open terrain, the growth of crops or other seasonal vegetation can create a permanent or seasonal sight distance obstruction. Furthermore, the properties upon which obstructions might exist are commonly owned by the railroad or others. Evaluate installation of active devices at any location where adequate sight distances cannot be provided. Include communication with the railroad and the WUTC in your evaluation.

The driver of a vehicle stopped at a crossing with signal lights but no gates needs to be able to see far enough down the tracks from the stop bar to be able to cross the tracks before a train, approaching at maximum allowable speed, reaches the crossing (see Exhibit 1350-1, Case 1).

(b) Highway Grade and Crossing Angle

Construct highway grades so that low-clearance vehicles do not hang up on tracks or damage them. (See Chapter 1220 for information on vertical alignment at railroad grade crossings.) Whenever possible, design the roadway to cross grade crossings at right angles. If bicycle traffic uses the crossing (this can be assumed for most roads), provide a shoulder through the grade crossing at least as wide as the approach shoulder width. If a skew is unavoidable, wider shoulders may be needed to permit bicycles to maneuver to cross the tracks at right angles. (See Chapter 1520 for information on bikeways crossing railroad tracks.) Consider installation of advance warning signs indicating the presence of a skewed crossing for crossings where engineering judgment suggests a benefit.

Include any engineering studies or sight distance measurements in the Design Documentation Package (DDP).



d_t = Sight distance along railroad tracks (ft)
d_h = Sight distance along highway (ft)
d_e = Distance from driver to front of vehicle (8 ft)
D = Distance from stop line to nearest rail (15 ft)
W = Distance between outer rails (single track W=5 ft)
V_v = Velocity of vehicle (mph)
f = Coefficient of friction
V_t = Velocity of train (mph)
L = Length of vehicle (65 ft)

Notes:

- Adjust for skewed crossings.
- Assume flat highway grades adjacent to and at crossings.

Train Speed (mph) V_t	Case 1: Departure From Stop	Case 2: Moving Vehicle						
		Vehicle Speed (mph) V_v						
		10	20	30	40	50	60	70
		f=0.40	0.40	0.35	0.32	0.30	0.29	0.28
	Distance Along Railroad From Crossing d_t (ft)							
10	240	146	106	99	100	105	111	118
20	480	293	212	198	200	209	222	236
30	721	439	318	297	300	314	333	355
40	961	585	424	396	401	419	444	473
50	1,201	732	530	494	501	524	555	591
60	1,441	878	636	593	601	628	666	706
70	1,681	1,024	742	692	701	733	777	828
80	1,921	1,171	848	791	801	833	888	946
90	2,162	1,317	954	890	901	943	999	1,064
		Distance Along Highway From Crossing dh (ft)						
		69	135	220	324	447	589	751
Design sight distance for a combination of highway and train vehicle speeds and a 65-ft truck crossing a single set of tracks at 90° (AASHTO).								

Source: *A Policy on Geometric Design of Highway and Streets*, 2004, by the American Association of State Highway and Transportation Officials.

Sight Distance at Railroad Crossing
Exhibit 1350-1

1350.04 Traffic Control Systems

(1) Traffic Control System Elements

There are two categories of railroad warning devices: “passive” and “active.” Passive devices include all signs and pavement markings. Active devices include flashing light signals, railroad warning gates, and active advance warning systems, all of which are activated by approaching trains.

(a) Passive Elements

1. The following signing elements are shown in the MUTCD, Part 8, Traffic Control for Highway-Rail Grade Crossings:

    - **Highway-Rail Grade Crossing (Crossbuck) sign:** Crossbuck signs identify the location of the grade crossing and convey the same meaning as a yield sign. The railroad is responsible for installation and maintenance of Crossbuck signs.

      Note: Railroads are required to upgrade standard Crossbuck signs at passive grade crossings to “Crossbuck Assemblies” by December 31, 2019. Crossbuck Assemblies are Crossbuck signs mounted in conjunction with STOP or YIELD signs. Any projects that establish new passive crossings or result in reconstruction of passive crossings should include design of Crossbuck Assemblies. (See Chapter 8 of the MUTCD for additional guidance.)

    - **Supplemental Number of Tracks (inverted “T”) sign:** This sign is mounted below the Crossbuck sign to indicate the number of tracks when two or more tracks are involved. The railroad is responsible for installation and maintenance of these signs.

    - **Grade Crossing Advance Warning sign (W10 sign series):** The road authority is responsible for installation and maintenance of these signs.

    - **Exempt sign:** This is a supplemental sign that, when authorized by the WUTC, may be mounted below the Crossbuck sign. When this sign is approved, certain classes of vehicles, otherwise required to stop before crossing the tracks, may proceed without stopping, provided no train is approaching. The road authority is responsible for installation and maintenance of these signs.

    - **Do Not Stop on Tracks sign:** This sign is used where it is determined that additional emphasis is needed to remind motorists of this legal requirement, such as where nearby roadway intersections result in queuing back across the tracks. The road authority is responsible for installation and maintenance of these signs.

2. Pavement markings on all paved approaches are the responsibility of the road authority and consist of **RR Crossing** markings in accordance with the *Standard Plans*, **No Passing** markings, and **Pullout Lanes**, as appropriate.

3. Consider the installation of illumination at and adjacent to railroad crossings where an engineering study determines that better nighttime visibility of the train and the grade crossing is needed. For example, where:
   - A substantial number of railroad operations are conducted at night.
   - Grade crossings are blocked for long periods at night by slow-speed trains.
   - Collision history indicates that drivers experience difficulty seeing trains during hours of darkness.

(b) Active Elements

1. **Railroad Flashing Light Signals and Gates:** These are active devices intended to warn motorists of approaching trains and impose a stopping requirement. The railroad is responsible for installation and maintenance of these devices.

2. **Traffic Signal Interconnection (also known as "railroad preemption"):** These provide linkage between the railroad signals and adjacent traffic signals to allow vehicles to clear the tracks at a traffic signal as a train approaches. They are typically funded by the road authority and require cooperation with the railroad for installation. The formation of a Railroad Crossing Evaluation Team is required to determine signal railroad preemption requirements. (See Chapter 1330 for further guidance.)

3. **Pre-Signals:** These are traffic control signal faces that control roadway traffic approaching a grade crossing in conjunction with the traffic control signal faces that control traffic approaching a roadway-roadway intersection beyond the tracks. Pre-signals are typically used where the clear storage distance is insufficient to store one or more design vehicles.

4. **Active Advance Warning Systems:** These are supplemental flashing yellow beacons mounted along with the grade crossing advance warning signs that are interconnected to the railroad active warning devices. Activation of the railroad active warning devices activates the beacons to provide motorists with an advance indication that a train is approaching or occupying the crossing. Active advance warning systems are typically used where roadway geometry prevents a clear view of the grade crossing ahead, or where higher highway speeds may require advance notification of an impending stopping requirement. Use a plaque stating "Train When Flashing" as part of such systems.

5. **Supplemental Safety Devices:** Supplemental safety devices are typically used at locations where it is known that motorists frequently drive around gates, where unique local safety hazards exist, or as part of railroad quiet zones where trains are no longer required to sound the locomotive horn. (For more information about quiet zones, see www.fra.dot.gov/us/content/1318.)

   Typical supplemental safety devices include:
   - Four-Quadrant Gate Systems: These are additional gates placed on the opposite side of the roadway from the primary railroad warning gates that, when lowered, make it impossible for motorists to drive around the lowered gates. (See Chapter 8 of the MUTCD for additional information on four-quadrant gate systems.

- Median Separators: This is a system of raised delineators extending along the roadway centerline back from the tip of a lowered railroad warning gate that prevents motorists from being able to drive around the lowered gates. Make median separators at least 60 feet in length where sufficient space is available.

(c) Selection of Grade Crossing Warning Devices

At a minimum:

- All public grade crossings are required to be equipped with Crossbuck signs, a supplemental plaque indicating the presence of multiple tracks (if applicable), and advance warning signs.
- Railroad pavement markings are required at all crossings where active warning devices are present or the posted legal speed limit is 40 mph or higher.

Passive warning devices notify drivers that they are approaching a grade crossing and to be on the lookout for trains. In general, consider stand-alone passive warning devices at grade crossings with low volumes and speeds on both the highway and railway, and where adequate sight distances exist. Active warning devices are to be considered at all other crossings. No national or state warrants have been developed for installation of traffic control devices at grade crossings. Furthermore, due to the large number of significant variables that need to be considered, there is no single system of active traffic control devices universally applicable for grade crossings. Warning systems at grade crossings should be based on an engineering and traffic investigation, including input from the railroad and the WUTC. Primary factors to consider in selecting warning devices are train and highway volumes and speeds; highway and railway geometry; pedestrian volume; accident history; and available sight distance.

Evaluate railroad signal supports and gate mechanisms as roadside features to be considered for mitigation. Use traffic barrier or impact attenuators as appropriate (see Division 16).

1350.05 Nearby Roadway Intersections

Operations at roadway intersections located near grade crossings can present significant challenges for grade crossing safety. In particular, vehicle queues originating from the roadway intersection and extending back to the grade crossing must be clear of the tracks before the arrival of any trains. While RCW 46.61.570 prohibits motorists from stopping on any railroad tracks, it is not uncommon for motorists to stop on tracks when focusing on the downstream highway intersection rather than the immediate grade crossing.

For signalized highway intersections where vehicle queues result from a red signal indication, clearance of vehicles from the grade crossing is accomplished through traffic signal interconnection with the railroad warning signals (“railroad preemption”). When railroad preemption is in place, an approaching train will initiate a special mode within the highway traffic signal specifically designed to clear any vehicles from the tracks prior to the arrival of the train at the grade crossing. Railroad preemption design involves a specialized analysis that considers the distance between the roadway intersection and grade crossing; queue clearance times; train speeds; the capabilities of the railroad active warning devices; and other traffic signal phases.

Where the distance between the grade crossing and the roadway intersection is not sufficient to store a design vehicle, a pre-signal may be considered to prevent subsequent vehicles from entering the grade crossing limits during the track clearance phases of the downstream highway signal. Additionally, whenever a signalized roadway intersection is located 500 feet from a grade crossing, a Railroad Crossing Evaluation Team, which includes representatives from both WSDOT and the railroad company, will jointly determine the need for and design of railroad preemption systems. (See Chapter 1330 for further guidance on railroad preemption requirements.)

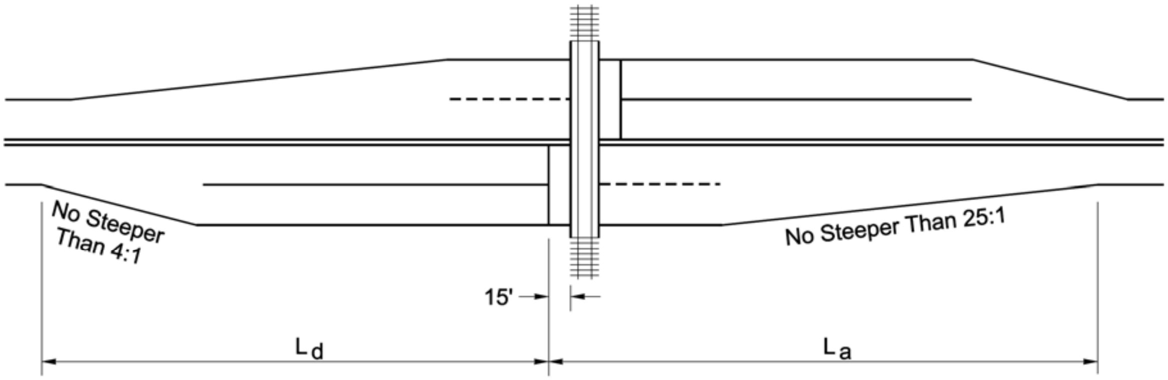
Vehicle queues over the tracks can also result from operations at nonsignalized roadway intersections; for example, where there is a short distance between the grade crossing and a roadway intersection controlled by a STOP or YIELD sign. A “Do Not Stop on Tracks” sign should be installed at locations where the distance between the grade crossing and the roadway intersection is not sufficient to store a design vehicle or it is otherwise determined that vehicle queues originating from the roadway intersection routinely extend back to the grade crossing. To determine whether or not to consider a highway traffic signal in such instances, refer to MUTCD Traffic Signal Warrant 9.

1350. 06 Pullout Lanes

In accordance with RCW 46.61.350, certain vehicles are required to stop at all railroad crossings unless the grade crossing is flagged or an “Exempt” sign is posted. Evaluate the installation of “pullout” lanes when grade crossings have no active protection. Some school districts have a policy that school buses must stop at all grade crossings regardless of the type of control. Consider the installation of pullout lanes at any public grade crossing used regularly by school buses or by trucks transporting flammable cargo or explosives and at which they must stop.

Contact the local school district for school bus information. Contact the Truck Freight Program and Policy Manager at the WSDOT HQ Freight Systems Division about truck freight operations in the project vicinity.

Design pullout lane geometrics in accordance with Exhibit 1350-2. The minimum shoulder width adjacent to the pullout lane is 3 feet.



Ld = Total length of pullout lane, approach
La = Total length of pullout lane, exit

Approach Length of Pullout Lane, L_d		**Downstream Length of Pullout Lane, L_a**	
Vehicle Speed (mph)	**Length (ft)**	**Vehicle Speed (mph)**	**Length (ft)**
30	235	30	*
40	320	40	360
50	435	50	720
60	530	60	1,200
*Taper length only			

Typical Pullout Lane at Railroad Crossing
Exhibit 1350-2

1350.07 Crossing Surfaces

Railroads are responsible for the maintenance of crossing surfaces up to 12 inches outside the edge of rail (WAC 480-62-225). Crossing surfaces can be constructed of a number of different materials, including asphalt, concrete, steel, timber, rubber, or plastic. The most common surface types used on state highway crossings are asphalt, precast concrete, and rubber. Timbered crossings are frequently used for low-volume roads and temporary construction crossings.

The life of a crossing surface depends on the volume and weight of highway and rail traffic using it. Highway traffic not only dictates the type of crossing surface, but it also has a major influence on the life of the crossing. Rough crossing surfaces impact the motoring public far more than the railroad. Therefore, when a highway project passes through a railroad grade crossing, consider the condition of the crossing surface. While the existing condition might not warrant railroad investment in replacing it, the surface might have deteriorated sufficiently to increase vehicle operating costs and motorist inconvenience. In such cases, it may be effective to partner with the railroad to replace the crossing as part of the highway project. Such partnerships typically consist of the state reimbursing the railroad for all or a portion of the cost of the work.

1350.08 Crossing Closure

The MUTCD states, “Any highway-rail grade crossing that cannot be justified should be eliminated.” Coordination with the appropriate railroad and the Washington Utilities and Transportation Commission is required before any grade crossing can be closed. If a state route grade crossing appears unused, consult the HQ Railroad Liaison before taking any action. Close at-grade crossings that are replaced by grade separations.

1350.09 Traffic Control During Construction and Maintenance

Provide work zone traffic control for projects at highway-rail grade crossings, which need protection from train traffic. When highway construction or maintenance activities affect a railroad crossing, the railroad company must be notified at least ten days before performing the work (WAC 480-62-305(4)). Furthermore, whenever highway construction or maintenance crews or equipment are working within 25 feet of an active rail line or grade crossing, consult the railroad to determine whether a railroad flagger is required. Current contact numbers for railroads may be obtained by contacting your region Utilities Engineer or the HQ Railroad Liaison. Railroad flaggers differ from highway flaggers in that they have information on train schedules and can generally communicate with trains by radio. When flaggers are required, the railroad generally sends the road authority a bill for the cost of providing this service.

Do not allow work zone traffic to stop or queue up on a nearby rail-highway grade crossing unless railroad flaggers are present. Without proper protection, vehicles might be trapped on the tracks when a train approaches. (See the MUTCD for more detailed guidance.)

For projects requiring temporary access across a set of railroad tracks, contact the HQ Railroad Liaison early in the design process since a railroad agreement or permit will likely be required.

1350.10 Railroad Grade Crossing Petitions and WUTC Orders

The Washington Utilities and Transportation Commission (WUTC) is authorized by statute (Title 81 RCW) to have regulatory authority over railroad crossings. Establishing new crossings, closing existing crossings, or modifying existing grade crossings must be approved by the WUTC (WAC 480-62-150). WUTC authority does not apply within the limits of first class cities, in accordance with RCW 81.53.240. This is accomplished by submitting a formal petition to the WUTC for a formal order. The HQ Railroad Liaison will assist in the preparation and submittal of this petition. Include a copy of the petition and WUTC findings and order in the Design Documentation Package.

1350.11 Grade Crossing Improvement Projects

The HQ Highways and Local Programs Office (H&LP) administers the federal (Section 130) Grade Crossing Safety Improvement Program. Project proposals are submitted by local agencies, railroads, and WSDOT.

Contact H&LP or the HQ Railroad Liaison in the Utilities, Railroads, and Agreements Section for more information.

1350.12 Light Rail

Light rail transit systems have been implemented and will continue to be developed in some urban areas of the state. For the most part, criteria for light rail transit crossings are very similar to those for freight and passenger rail with the exception of locations where light rail shares a street right of way with motor vehicles. The MUTCD now includes guidance devoted exclusively to light rail transit and can be consulted as the situation warrants.

1350.13 Documentation

For the list of documents required to be preserved in the Design Documentation Package and the Project File, see the Design Documentation Checklist:
www.wsdot.wa.gov/design/projectdev/

(4) Cross Section

Provide the minimum ramp widths given in Exhibit 1360-6. Ramp traveled ways may need additional width to these minimums as one-way turning roadways. (See Chapters 1230 and 1240 for additional information and roadway sections.)

Cross slope and superelevation criteria for ramp traveled ways and shoulders are as given in Chapters 1230 and 1240 for roadways. At ramp terminals, the intersection lane and shoulder width design guidance shown in Chapter 1310 may be used.

Whenever feasible, make the ramp cross slope at the ramp beginning or ending station equal to the cross slope of the through lane pavement. Where space is limited and superelevation runoff is long, or when parallel connections are used, the superelevation transition may be ended beyond (for on-ramps) or begun in advance of (for off-ramps) the ramp beginning or ending station, provided that the algebraic difference in cross slope at the edge of the through lane and the cross slope of the ramp does not exceed 4%. In such cases, provide smooth transitions for the edge of traveled way.

Number of Lanes			1	2
Ramp Width (ft)	Traveled Way[1]		15[2]	25[3]
	Shoulders	Right	8	8
		Left	2	4
	Medians[4]		6	8

Notes:

[1] For turning roadway widths, see Chapter 1240, and for additional width when an HOV lane is present, see Chapter 1410.

[2] May be reduced to 12 ft on tangents.

[3] Add 12 ft for each additional lane.

[4] The minimum two-way ramp median width (including shoulders) is given. Wider medians may be required for signs or other traffic control devices and their respective clearances. When either the on- or off-ramp is single-lane, use the one-lane column. If both directions are two lanes, use the two-lane column.

Ramp Widths
Exhibit 1360-6

Ramp shoulders may be used by large trucks for offtracking and by smaller vehicles cutting to the inside of curves. To accommodate this increased use, pave shoulders full depth.

(5) Two-Way Ramps

Two-way ramps are on- and off-ramps on a single roadway. Design two-way ramps as separate one-way ramps. Provide a raised median to physically separate the on- and off-ramps. Wider medians than given in Exhibit 1360-6 may be required for signing or other traffic control devices and their clearances. (For signs, it is sign width plus 4 feet.) Where wider medians are required, provide a 2-foot clearance between the face of curb and the edge of traveled way. Where additional width is not required, the raised median width may be reduced to a double-faced mountable or extruded curb. Traffic barrier or a depressed median may be provided in place of the raised median.

(6) Ramp Lane Increases

When off-ramp traffic and left-turn movement volumes at the ramp terminal at-grade intersection cause excessive queue length, it may be desirable to add lanes to the ramp to reduce the queue length caused by congestion and turning conflicts. Make provision for the addition of ramp lanes whenever ramp exit or entrance volumes are expected, after the design year, to result in an undesirable level of service (LOS). (See Chapter 1210 for width transition design.)

(7) Ramp Meters

Ramp meters are used to allow a measured or regulated amount of traffic to enter the freeway. When operating in the "measured" mode, they release traffic at a measured rate to keep downstream demand below capacity and improve system travel times. In the "regulated" mode, they break up platoons of vehicles that occur naturally or result from nearby traffic signals. Even when operating at near capacity, a freeway main line can accommodate merging vehicles one or two at a time, while groups of vehicles will cause main line flow to break down.

The location of the ramp meter is a balance between the storage and acceleration criteria. Locate the ramp meter to maximize the available storage and so that the acceleration lane length, from a stop to the freeway main line design speed, is available from the stop bar to the merging point. With justification, the average main line running speed during the hours of meter operation may be used for the highway design speed to determine the minimum acceleration lane length from the ramp meter. (See 1360.06(4) for information on the design of on-connection acceleration lanes and Chapter 1050 for additional information on the design of ramp meters.)

Driver compliance with the signal is required for the ramp meter to have the desired results. Consider enforcement areas with metered ramps.

Consider HOV bypass lanes with ramp meters. (See Chapter 1410 for design data for ramp meter bypass lanes.)

1360.06 Interchange Connections

To the extent practicable, provide uniform geometric design and uniform signing for exits and entrances in the design of a continuous freeway. Do not design an exit ramp as an extension of a main line tangent at the beginning of a main line horizontal curve.

Provide spacing between interchange connections as given in Exhibit 1360-3.

Avoid on-connections on the inside of a main line curve, particularly when the ramp approach angle is accentuated by the main line curve, the ramp approach results in a reverse curve to connect to the main line, or the elevation difference will cause the cross slope to be steep at the nose.

Keep the use of mountable curb at interchange connections to a minimum. Provide justification when curb is used adjacent to traffic with a design speed of 40 mph or higher.

(d) **Urban Off-Connection Design**

Design left-side HOV direct access off-connections in urban areas as follows:

1. Either the parallel (desirable) or the taper (with justification) design may be used.
2. Use the longer deceleration length of: the Deceleration Length for Buses (see Exhibit 1420-14) from a 60 mph freeway speed to the ramp design speed (see 1420.05(2)) or the Minimum Deceleration Length given in Chapter 1360 from the freeway design speed to the ramp design speed.

(e) **Rural Off-Connection Design**

Design left-side HOV direct access off-connections in rural areas using a freeway design speed as given in Chapter 1140.

(8) Vertical Clearance

Vertical clearance for a structure over a road is measured from the lower roadway surface, including the usable shoulders, to the bottom of the overhead structure.

Refer to Chapter 720 for information on vertical clearance. For a new structure and for a new ramp under an existing structure, the minimum vertical clearance is 16.5 feet. A deviation will be considered for a 14.5-foot minimum vertical clearance for a new HOV direct access ramp under an existing bridge.

The minimum vertical clearance for a pedestrian grade separation over any road is 17.5 feet.

(9) Flyer Stops

Design flyer-stop ramp on-connections as given in 1420.05(6), and design off-connections as given in 1420.05(7). Flyer stop connections are included in the access point spacing discussed in 1420.04(1)(a).

Design the ramp to the flyer stop in accordance with 1420.05(3), 1420.05(4), and 1420.05(5).

The minimum width for the roadway at a flyer stop is 24 feet.

When a flyer stop is in the median, provide enough median width for the flyer stop roadway, the passenger facilities, and barrier separation without reducing the width of the through lanes or shoulders (see 1420.06).

The approval of a flyer stop requires the operational analysis portion of the interchange justification report (see Chapter 550).

(10) T Ramps

A T ramp example and design is shown in Exhibit 1420-15.

1420.06 Passenger Access

When designing transit stops, include accessibility (compliance with the ADA), safety, and the comfort of passengers. Minimize pedestrian/vehicle conflict points. Design the whole facility with security in mind by keeping lines of sight as open as possible. Traffic barriers, fencing, illumination, landscaping, seating, windscreens, shelters, enclosed walkways, telephones, and posted schedules are examples of items that contribute to passenger safety and well-being. (See Chapter 1430 for passenger amenities at transit stops.)

(1) Passengers

To encourage use of the passenger access facility for an express transit stop, provide a route that is the shortest distance to travel from the park & ride lot or local transit stop. Failure to do so might generate the use of undesirable shortcuts. To encourage local use of the passenger access facilities, provide direct access from surrounding neighborhoods.

Provide grade separations for pedestrian access to transit stops in the median. Consider stairways, ramps, elevators, and escalators, but provide at least one access for the disabled at every loading platform, as required by the American with Disabilities Act of 1990. (See Chapter 1510 for guidance when designing pedestrian grade separations.)

The ADA Accessibility Guidelines for Buildings and Facilities states: “Platform edges bordering a drop-off and not protected by platform screens or guard rails shall have a detectable warning … 24 inches wide running the full length of the platform drop-off.” (See the *Standard Plans* for the detectable warning pattern.)

At transit stops, at-grade crosswalks are only permitted in the at-grade crossing flyer stop layout described in 1420.04(4)(a)2. Use traffic calming techniques, such as horizontal alignment, textured pavement and crosswalk markings, barrier openings, and other treatments, to channelize pedestrian movements and slow the transit vehicle’s movements. Illuminate transit stop crosswalks (see Chapter 1040).

Where at-grade crosswalks are not permitted, take steps to minimize unauthorized at-grade crossings. Fencing, taller concrete traffic barrier, enclosed walkways, and ramps are examples of steps that may be taken.

(2) Bicycles

Bike lanes on nearby streets and separate trails encourage people to bicycle from surrounding neighborhoods. Provide these bicyclists direct access to passenger access facilities.

Design bicycle access facilities in conjunction with the access for the disabled (see Chapters 1510, 1515, and 1520).

Locate bicycle parking outside of the passenger walkways (see Chapter 1430).

Locations near colleges and universities and locations with good bicycle access, especially near trails, will attract bicyclists. Contact the region Bicycle Coordinator for information on the predicted number of bicycle parking spaces needed and the types of bicycle racks available.

(b) **Internal Circulation**

Locate major circulation routes within a park & ride lot at the periphery of the parking area to minimize vehicle-pedestrian conflicts. Accommodate all modes using that part of the facility. Take care that an internal intersection is not placed too close to a street intersection. Consider a separate loading area with priority parking for vanpools. Whenever possible, do not mix buses with cars.

Design bus circulation routes to provide for easy movement, with efficient terminal operations and convenient passenger transfers. A one-way roadway with two lanes to permit the passing of stopped buses is desirable, with enough curb length and/or sawtooth-type loading areas to handle the number of buses using the facility under peak conditions (see 1430.05). Close coordination with the local transit authority is critical in the design of internal circulation for buses and vanpools.

Locate the passenger loading zone either in a central location to minimize the pedestrian walking distance or near the end of the facility to minimize the transit travel time.

Large lots may need more than one waiting area for multiple buses.

In an undersized or oddly-shaped lot, circulation may have to be compromised in order to maximize utilization of the lot. Base the general design for the individual user modes on the priority sequence of: pedestrians, bicycles, feeder buses, and park & ride area. Design traffic circulation to minimize vehicular travel distances, conflicting movements, and the number of turns. Disperse vehicular movements within the parking area by the strategic location of entrances, exits, and aisles. Align aisles to facilitate convenient pedestrian movement toward the bus loading zone.

Design bus routes within the internal layout, including entrance and exit driveways, to the turning radius of the bus. Additional considerations for internal circulation are:

- Design the lot to be understandable to all users (auto, pedestrian, bicycle, and bus).
- Do not confront drivers with more than one decision at a time.
- Provide adequate capacity at entrances and exits.
- Make signing clear and ADA-compliant.
- Provide for future expansion.

(c) **Parking Area Design**

Normally, internal circulation is two way with 90° parking. However, due to the geometrics of smaller lots, one-way aisles with angled parking may be advantageous.

For additional information on parking requirements for the disabled, see 1430.10. For information on parking area design, see the *Roadside Manual*.

(d) **Pedestrian Movement**

Pedestrian movement in parking areas is normally by way of the drive aisles. Make a pedestrian's path from any parking stall to the loading zone as direct as possible.

Provide walkways to minimize pedestrian use of a circulation road or an aisle and to minimize the number of points at which pedestrians cross a circulation road. Where pedestrian movement originates from an outlying part of a large parking lot, consider a walkway that extends toward the loading zone in a straight line.

For additional criteria for pedestrian movement, see Chapter 1510 and the *Roadside Manual.*

Include facilities for disabled patrons. For additional information on accessibility for the disabled, see 1430.10.

(e) **Bicycle Facilities**

Encouraging the bicycle commuter is important. Provide lots that are served by public transit, with lockers or with a rack that will support the bicycle frame and allow at least one wheel to be locked. Locate the bike-parking area relatively close to the transit passenger-loading area, separated from motor vehicles by curbing or other physical barriers, and with a direct route from the street. Design the bicycle-parking area to discourage pedestrians from inadvertently walking into the area and tripping. Consider providing shelters for bicycle racks. For bicycles, the layout normally consists of stalls 2.5 feet x 6 feet, at 90° to aisles, with a minimum aisle width of 4 feet. For additional information on bicycle facilities, see Chapters 1515 and 1520.

(f) **Motorcycle Facilities**

Provide parking for motorcycles. For information on motorcycle parking, see the *Roadside Manual*.

(g) **Drainage**

Provide sufficient slope for surface drainage, as ponding of water in a lot is undesirable for both vehicles and pedestrians. This is particularly true in cold climates where freezing may create icy spots. The maximum grade is 2%. Install curb, gutter, and surface drains and grates where needed. Coordinate drainage design with the local agency to make sure appropriate codes are followed. For additional drainage information, see Chapter 800 and the *Roadside Manual*.

(h) **Pavement Design**

Design pavement to conform to design specifications for each of the different uses and loadings that a particular portion of a lot or roadway is expected to handle. For pavement type selection, see Chapter 620.

(i) **Traffic Control**

Control of traffic movement can be greatly improved by proper pavement markings. Typically, reflectorized markings for centerlines, lane lines, channelizing lines, and lane arrows are needed to guide or separate patron and transit traffic. Install park & ride identification signs. For signing and pavement markings, see Chapters 1020 and 1030 and the MUTCD.

Chapter 1510 Pedestrian Facilities

1510.01 General

Pedestrian travel is a vital transportation mode. It is used at some point by nearly all citizens and is the main link to everyday life for many. Washington State Department of Transportation (WSDOT) designers must be aware of the various physical needs and abilities of pedestrians. Accommodate this variation in design to allow universal access.

The Americans with Disabilities Act of 1990 (ADA) requires that pedestrian facilities be designed and constructed such that they are readily accessible and usable by individuals with disabilities. This chapter provides accessibility criteria for the design of pedestrian facilities that meet state and national standards.

In addition to the ADA requirements, design pedestrian facilities using guidance in the *Roadside Manual*, the *Design Manual*, and the *Standard Plans*.

Designers face multiple challenges developing facilities that address pedestrian needs within a limited amount of right of way. Designers must:

- Become familiar with all the accessibility criteria requirements.
- Evaluate all pedestrian facilities within project limits for compliance with ADA.
- Recognize those features and elements in existing pedestrian facilities that meet or do not meet accessibility criteria.
- Design facilities that meet accessibility criteria.
- Balance intersection designs to meet the needs of pedestrians and vehicles.
- Design pedestrian access routes to be free of obstacles.
- Avoid the use of pedestrian space for snow storage in areas of heavy snowfall. (Coordinate with region maintenance personnel.)

Consider the maintainability of all designs for all pedestrian facilities and accessible features. Coordinate designs with the responsible WSDOT or local agency maintenance entity to ensure the understanding of maintenance requirements. Title II of the Americans with Disabilities Act requires that all necessary features be accessible and maintained in operable working condition for use by individuals with disabilities.

1510.02 References

(1) Federal/State Laws and Codes

Americans with Disabilities Act of 1990 (ADA) (28 Code of Federal Regulations [CFR] Part 36, Appendix A, as revised July 1, 1994)

23 CFR Part 652, Pedestrians and Bicycle Accommodations and Projects

28 CFR Part 35, Nondiscrimination on the Basis of Disability in State and Local Government Services

49 CFR Part 27 (Authority: Section 504 of the Rehabilitation Act of 1973, as amended – 29 USC 794)

Revised Code of Washington (RCW) 35.68, Sidewalks, gutters, curbs and driveways – All cities and towns

RCW 35.68.075, Curb ramps for persons with disabilities – Required – Standards and requirements

RCW 35.78, Streets – Classification and design standards

RCW 46.04.160, Crosswalk

RCW 46.61.235, Crosswalks

RCW 46.61.240, Crossing at other than crosswalks

RCW 46.61.261, Sidewalks, crosswalks – Pedestrians, bicycles

RCW 47.24.010, City streets as part of state highways, Designation – Construction, maintenance – Return to city or town

RCW 47.24.020, City streets as part of state highways – Jurisdiction, control

RCW 47.30.030, Facilities for nonmotorized traffic

RCW 47.30.050, Expenditures for paths and trails

(2) Design Guidance

A Policy on Geometric Design of Highways and Streets (Green Book), AASHTO, Current version

Accessible Rights-of-Way: A Design Guide, U.S. Access Board, Washington D.C.
http://www.access-board.gov/prowac/guide/prowguide.htm

Americans with Disabilities Act and Architectural Barriers Act Accessibility Guidelines (ADAAG), July 23, 2004, U.S. Access Board (The 1991 ADAAG is the current standard for buildings & on-site facilities adopted by US Department of Justice, the 2004 ADA-ABAAG is expected to be adopted.)
www.wbdg.org/ccb/astand/ada_aba.pdf

"Design Guidance, Accommodating Bicycle and Pedestrian Travel: A Recommended Approach," USDOT Policy Statement, 2001
www.fhwa.dot.gov/environment/bikeped/design.htm

Designing Sidewalks and Trails for Access – Parts I & II, USDOT, FHWA, 2001
http://www.fhwa.dot.gov/environment/sidewalk2/index.htm

Guide for the Planning, Design, and Operation of Pedestrian Facilities, AASHTO, 2004. Provides guidance on the planning, design, and operation of pedestrian facilities along streets and highways. Specifically, the guide focuses on identifying effective measures for accommodating pedestrians on public rights of way. It can be purchased through the AASHTO website.

Highway Capacity Manual, Transportation Research Board (TRB), 2000

Manual on Uniform Traffic Control Devices for Streets and Highways, USDOT, FHWA; as adopted and modified by Chapter 468-95 WAC “Manual on uniform traffic control devices for streets and highways” (MUTCD)
www.wsdot.wa.gov/publications/manuals/mutcd.htm

Pedestrian Facilities Guidebook: Incorporating Pedestrians Into Washington’s Transportation System, OTAK, 1997
www.wsdot.wa.gov/publications/manuals/fulltext/m0000/pedfacgb.pdf

Pedestrian Facilities Users Guide – Providing Safety and Mobility, FHWA, 2002. Provides useful information regarding walkable environments, pedestrian crashes and their countermeasures, and engineering improvements for pedestrians.
http://drusilla.hsrc.unc.edu/cms/downloads/PedFacility_UserGuide2002.pdf

Revised Draft Guidelines for Accessible Public Rights-of-Way (PROWAG), Nov. 23, 2005, U.S. Access Board
www.access-board.gov/prowac/draft.htm

Roadside Manual, M 25-30, WSDOT
www.wsdot.wa.gov/publications/manuals/m25-30.htm

“Special Report: Accessible Public Rights-of-Way – Planning & Designing for Alterations,” Public Rights-of-Way Access Advisory Committee, July 2007
www.access-board.gov/prowac/alterations/guide.htm

Standard Plans for Road, Bridge, and Municipal Construction (Standard Plans), M 21-01, WSDOT
www.wsdot.wa.gov/publications/manuals/m21-01.htm

Understanding Flexibility in Transportation Design – Washington, WSDOT, 2005
www.wsdot.wa.gov/research/reports/600/638.1.htm

Washington State Bicycle and Pedestrian Plan
www.wsdot.wa.gov/bike/bike_plan.htm

1510.03 Definitions

accessible A facility in the public right of way that is usable by persons with disabilities.

accessible pedestrian signals A device that communicates information about the "WALK" phase in audible and vibrotactile (vibrating surface that communicates information through touch, located on the accessible pedestrian signal button) formats.

accessible route See ***pedestrian access route***.

ADA An abbreviation for the Americans with Disabilities Act of 1990. The ADA is a civil rights law that identifies and prohibits discrimination based on disability. Title II of the ADA requires public entities to design new facilities or alter existing facilities, including sidewalks and trails, to be accessible to people with disabilities.

alternate pedestrian access route A temporary accessible route to be used when the existing pedestrian access route is blocked by construction, alteration, maintenance, or other temporary condition.

alterations A change to a facility in the public right of way that affects or could affect access, circulation, or use.

Alterations include, but are not limited to, renovation; rehabilitation; reconstruction; historic restoration; resurfacing of circulation paths or vehicular ways; or changes or rearrangement of structural parts or elements of a facility.

Alterations *do not* include:

- Pavement pothole patching.
- Liquid-asphalt sealing, chip seal, bituminous surface treatment, or crack sealing.
- Lane restriping that does not involve roadway widening.

bituminous surface treatment (BST) Also known as a seal coat or chip seal, a BST is a thin, protective wearing surface that is applied to the pavement.

buffer A space at least 3 feet wide from the back of the curb to the edge of the sidewalk that could be treated with planting or alternate pavement.

clear width The required 4-foot minimum width to provide the pedestrian access route.

counter slope Any slope opposing the running slope of a curb ramp.

cross slope The slope measured perpendicular to the direction of travel.

crosswalk A marked or unmarked pedestrian crossing, typically at an intersection, that connects the designated pedestrian access route (such as a sidewalk, shoulder, or pathway) on opposite sides of a roadway. A crosswalk must meet accessibility standards.

A crosswalk is also defined as:

- "…the portion of the roadway between the intersection area and a prolongation or connection of the farthest sidewalk line or in the event there are no sidewalks then between the intersection area and a line ten feet therefrom, except as modified by a marked crosswalk" (RCW 46.04.160).

- “(a) That part of a roadway at an intersection included within the connections of the lateral lines of the sidewalks on opposite sides of the highway measured from the curbs or in the absence of curbs, from the edges of the traversable roadway, and in the absence of a sidewalk on one side of the roadway, the part of the roadway included within the extension of the lateral lines of the sidewalk at right angles to the center line; (b) Any portion of a roadway at an intersection or elsewhere distinctly indicated as a pedestrian crossing by lines on the surface, which may be supplemented by contrasting pavement texture, style, or color” (MUTCD, 2003; *Guide for the Planning, Design, and Operation of Pedestrian Facilities*, AASHTO, 2004).

curb extension A curb and sidewalk bulge or extension out into the parking lane or shoulder used to decrease the length of a pedestrian crossing and increase visibility for the pedestrian and driver.

curb flare The sloped area that may occur between the curb ramp and the sidewalk to accommodate the change in grade.

curb line A line at the face of the curb that marks the transition between the curb and the gutter, street, or highway.

curb ramp A combined ramp and landing to accomplish a change in level at a curb. This element provides street and sidewalk access to pedestrians using wheelchairs. Curb ramp is the term used in the ADA. (The WSDOT *Standard Plans* and *Standard Specifications* use the term “sidewalk ramp.”)

parallel curb ramp A curb ramp design where the sidewalk slopes down to a landing at road level and then slopes back up to the sidewalk so that the running slope is in line with the direction of sidewalk travel.

perpendicular curb ramp A curb ramp design where the ramp path is perpendicular to the curb or meets the gutter grade break at right angles.

design area The design area is defined as follows:

rural design area An area that meets none of the conditions to be an urban area (see Chapter 1140).

suburban design area A term for the area at the boundary of an urban area. Suburban settings may combine the higher speeds common in rural areas with activities that are associated with urban settings.

urban design area An area defined by one or more of the following:

- Adjacent to and including a municipality or other urban place having a population of 5,000 or more, as determined by the latest available published official federal census (decennial or special), within boundaries to be fixed by a state highway department, subject to the approval of the FHWA.
- Within the limits of an incorporated city or town.
- Characterized by intensive use of the land for the location of structures and receiving such urban services as sewer, water, and other public utilities and services normally associated with an incorporated city or town.
- With not more than 25% undeveloped land (see Chapter 1140).

detectable warning surface A tactile surface feature of truncated dome material built into or applied to the walking surface to alert persons with impairments of vehicular ways. Detectable warning surfaces shall contrast visually with the adjacent gutter, street or highway, and walkway surface. Note: The only acceptable detectable warnings are truncated domes as detailed in the *Standard Plans*.

driveway A vehicular access point to a roadway or parking facility with a curb or a slope (typically perpendicular to the curb) that cuts through or is built up to the curb to allow vehicles to effectively negotiate the elevation change between the street and the sidewalk.

element An architectural or mechanical component or design feature of a space, site, or public right of way.

facility All or any portion of buildings, structures, improvements, elements, and pedestrian or vehicular routes located in a public right of way.

feature A component of a pedestrian access route, such as a curb ramp, driveway, crosswalk, or sidewalk.

flangeway gap The space between the inner edge of a rail and the crossing surface or the gap for the train wheel.

grade break The intersection of two adjacent surface planes of different grade.

hand rail A narrow rail for support along walking surfaces, ramps, and stairs.

landing A level (0 to 2% grade in any direction) paved area, within or at the top and bottom of a stair or ramp, designed to provide turning and maneuvering space for wheelchair users and as a resting place for pedestrians.

maximum extent feasible From the U.S. Department of Justice, 28 CFR Part 36.402, Alterations: The phrase “to the maximum extent feasible” applies to the occasional case where the nature of the existing facility makes it virtually impossible to comply fully with applicable accessibility standards through a planned alteration.

midblock pedestrian crossing A marked pedestrian crossing located between intersections.

passenger loading zone An area where persons can enter a vehicle safely.

pedestrian Any person afoot or using a wheelchair, power wheelchair, or means of conveyance (other than a bicycle) propelled by human power, such as skates or a skateboard.

pedestrian access route (PAR) (same as ***accessible route***) A continuous, unobstructed walkway within a pedestrian circulation path that provides accessibility.

The pedestrian access route is connected to street crossings by curb ramps. It may include walkways; sidewalks; street crossings and crosswalks; overpasses and underpasses; courtyards; elevators; platform lifts; stairs; ramps; and landings. Where sidewalks are not provided, pedestrian circulation paths may be provided in the shoulder unless pedestrian use is prohibited.

Not all transportation facilities need to accommodate pedestrians. However, those that do accommodate pedestrians need to have an accessible route.

pedestrian circulation path A prepared exterior or interior way of passage provided for pedestrian travel. Includes independent walkways, sidewalks, and other types of pedestrian access routes.

pedestrian facilities Walkways such as sidewalks, walking and hiking trails, shared-use paths, pedestrian grade separations, crosswalks, and other improvements provided for the benefit of pedestrian travel. Pedestrian facilities are intended to be accessible routes.

pedestrian overpass or underpass A grade-separated pedestrian facility, typically a bridge or tunnel structure, over or under a major highway or railroad, that allows pedestrians to cross at a different level.

pedestrian refuge island An island in the roadway that physically separates the directional flow of traffic, provides pedestrians with a place of refuge, and reduces the crossing distance. Note: Islands with cut-through paths are more accessible to persons with disabilities than are raised islands.

person with disability An individual who has an impairment, including a mobility, sensory, or cognitive impairment, that results in a functional limitation in access to and use of a building or facility.

railroad track crossings Locations where a pedestrian access route intersects and crosses a railroad track.

raised median A raised island in the center of a road used to restrict vehicle left turns and side street access. Note: Islands with cut-through paths are more accessible to persons with disabilities than are raised islands.

ramp A ramp is defined as:

- A sloped transition between two elevation levels (AASHTO).
- A walking surface between two level landings with a running slope steeper than 20H:1V (5%) (*Americans with Disabilities Act and Architectural Barriers Act Accessibility Guidelines*, July, 2004).

roadway See Chapter 1140.

running slope A slope measured in the direction of travel, normally expressed as a percent.

sidewalk That portion of a highway, road, or street between the curb line, or the edge of a roadway and the adjacent property line that is paved or improved and intended for use by pedestrians.

sidewalk ramp See ***curb ramp***.

site A parcel of land bounded by a property line or a designated portion of a public right of way.

street furniture Sidewalk equipment or furnishings, including garbage cans, benches, parking meters, and telephone booths.

traffic calming Design techniques that have been shown to reduce traffic speeds and unsafe maneuvers. These techniques can be stand-alone or used in combination, and they include lane narrowing, sidewalk extensions, surface variations, and visual clues in the vertical plane.

transit stop An area designed for bus boarding and disembarking.

traveled way (same as ***vehicular way***) A route provided for vehicular traffic. The portion of the roadway intended for the movement of vehicles, exclusive of shoulders and lanes for parking, turning, and storage for turning.

truncated domes Small raised protrusions of a detectible warning surface that are between $\frac{7}{8}$ inch and $1\frac{7}{16}$ inch in diameter and $\frac{3}{16}$ inch in height arranged in a distinctive pattern that is readily detected and understood by a vision-impaired person using the sense of touch guidance. The *Standard Plans* shows the appropriate pattern and dimensions.

universal access A facility that provides access to all persons regardless of ability or stature.

walk interval That phase of a traffic signal cycle during which the pedestrian is to begin crossing, typically indicated by a WALK message or the walking person symbol and its audible equivalent.

walkway The continuous portion of the pedestrian access route that is connected to street crossings by curb ramps.

wheeled mobility device A wheelchair, scooter, walker, or other wheeled device that provides mobility to those with limited physical abilities.

1510.04 Policy

(1) General

Provide pedestrian facilities along and across sections of state routes and city streets as an integral part of the transportation system. Federal Highway Administration (FHWA) and WSDOT policy is that bicycle and pedestrian facilities be given full consideration on all highway Improvement projects. Coordinate with the region Planning and Traffic offices to identify planning studies that detail current traffic and forecast growth and pedestrian generators in the project vicinity. FHWA is designated by the Department of Justice to ensure compliance with the Americans with Disabilities Act of 1990 (ADA) for transportation projects. Design pedestrian facilities to provide universal access for all people. Provide pedestrian facilities on highway projects unless one or more of the following conditions are met:

- Pedestrians are prohibited by law from using the facility.
- Planning/land use documents indicate that low population density is projected for the area in the 20-year planning horizon.

Consider whether or not the project is within a city or an urban growth area that is ultimately intended to be developed as an urban density area with urban services, including transit. Inside incorporated cities, design pedestrian facilities in accordance with the city design standards adopted in accordance with RCW 35.78.030 on the condition they comply with the most current ADA requirements.

Title II of the Americans with Disabilities Act requires that a public entity shall maintain in operable working condition those features of facilities and equipment that are required to be readily accessible to and usable by persons with disabilities. Consider the maintenance needs of accessible pedestrian facilities during the design of those elements.

(2) ADA Compliance

Wherever pedestrian facilities are intended to be a part of the transportation facility, 28 CFR Part 35 requires that those pedestrian facilities meet ADA guidelines. Federal regulations require that all new construction, reconstruction, or alteration of existing transportation facilities be designed and constructed to be accessible and useable by those with disabilities and that existing facilities be retrofitted to be accessible. Design pedestrian facilities to accommodate all types of pedestrians, including children, adults, the elderly, and persons with mobility, sensory, or cognitive impairments.

(a) Improvement Projects

Improvement projects address the construction of a new roadway, reconstruction such as roadway widening to add an additional lane, and modal (transit or bicycle) or lane configuration changes that widen the existing roadway cross section. For these projects, pedestrians' needs are assessed and included in the project. Develop pedestrian facilities consistent with the accessibility criteria listed in Exhibits 1510-23 and 1510-27.

(b) Pavement Preservation (Alteration) Projects

Preservation projects are considered alterations. Alterations include, but are not limited to, renovation; rehabilitation; reconstruction; historic restoration; lane restriping as part of an overlay; resurfacing of circulation paths or vehicular ways; or changes or rearrangement of structural parts or elements of a facility. The following guidance applies to alteration projects:

- Assess all existing curb ramps and crosswalks (marked or not) to determine whether curb ramp and crosswalk design elements meet the accessibility criteria in Exhibit 1510-27.
- Modify existing and proposed crosswalk slopes to meet the accessibility criteria. Justify the reasons for not meeting the accessibility criteria for crosswalk slopes and document in the Design Documentation Package (DDP). (See Chapter 300 for discussion about the DDP.)
- Modify existing curb ramps that do not meet the accessibility criteria to the maximum extent feasible. Where some curb ramps exist at intersections, ensure they exist on both ends of a crosswalk. A crosswalk must be accessible from both ends. This also may require reconstruction or modification of other ADA features (see Exhibit 1510-27) to ensure all elements of a curb ramp will meet the accessibility criteria.
- It is not always possible to fully meet accessibility requirements. If such a situation is encountered, consult with the Regional ADA Coordinator to develop a workable solution to meet accessibility requirements. If it is determined to be virtually impossible to meet accessibility requirements, document the variances to accessibility requirements with alternatives, justifications, and a final recommendation (called a Maximum Extent

Feasible document). The document will be approved by the appropriate Assistant State Design Engineer (ASDE) and the HQ ADA Compliance Officer, and will be included in the DDP.

- If the project is within a city, coordinate with the city to address accessibility requirements. Document the city's concurrence in the DDP.

The following are not considered alterations and therefore are not subject to accessibility requirements:

- Pavement pothole patching
- Liquid-asphalt sealing, chip seal, or crack sealing
- Lane restriping that does not involve roadway widening

(3) Jurisdiction

When city streets form a part of the state highway system within the corporate limits of cities and towns, the city has full responsibility for and control over any facilities beyond the curbs and, if no curb is installed, beyond that portion of the highway used for highway purposes (RCW 47.24.020). When proposed projects will damage or remove existing sidewalks or other pedestrian access routes or features within a city's jurisdiction, work with the city to reconstruct the affected facilities to meet accessibility criteria. When proposed alteration projects are within the city limits, assess the curb ramps and modify any that do not meet the accessibility criteria for alterations.

The title to limited access facilities within incorporated cities and towns remains with the state. If a turnback agreement has not been completed, the state maintains full jurisdiction within these areas (see Chapters 510, 520, and 530).

(4) Access Control

Access control on highways is either limited or managed and is discussed in detail in Division 5. Various designations of access control affect how and where pedestrian facilities are located, as follows:

(a) Full Limited Access Control

On roadways designated as having full limited access control, pedestrian access routes, hiking trails, and shared-use paths within the right of way are separated from vehicular traffic with physical barriers. These facilities can connect with other facilities outside the right of way once proper documentation has been obtained. Contact the Headquarters (HQ) Access and Hearings Section and HQ Real Estate Services to determine the required documentation. Grade separations are provided when the trail or path crosses the highway. (See Chapter 530 for limited access.)

(b) Partial or Modified Limited Access Control

On these facilities, pedestrian access routes and shared-use paths (see Chapter 1515) may be located between the access points of interchanges or intersections. Pedestrian crossings are usually either at grade or grade-separated. Consider midblock pedestrian crossings at pedestrian generators when the roadway has the characteristics associated with an urban or suburban area and has appropriate operational and geometric characteristics that allow for a crossing. Note that the installation of a midblock pedestrian crossing on a state highway is a design deviation that requires approval and documentation. Pedestrian circulation paths must include a pedestrian access route.

Consider providing sidewalks at signalized intersections. Evaluate extending sidewalks on a project-by-project basis. (See Chapter 530 for limited access.)

(c) Managed Access Control Highways

On these routes, in rural areas, paved shoulders are normally used for pedestrian travel. When pedestrian activity is high, separate walkways may be provided. Sidewalks are typically used in urban growth areas where there is an identified need for pedestrian facilities.

Consider providing sidewalks at signalized intersections. Evaluate extending sidewalks on a project-by-project basis.

Trails and shared-use paths, separated from the roadway alignment, are used to connect areas of community development. Pedestrian crossings are typically at grade.

1510.05 Pedestrian Facility Design

(1) Facilities

The type of pedestrian facility provided is based on access control of the highway; local transportation plans; comprehensive plans and other plans (such as Walk Route Plans) developed by schools and school districts; the roadside environment; pedestrian volumes; user age group(s); safety-economic analyses; and the continuity of local walkways along or across the roadway. Pedestrian access routes can either be immediately adjacent to streets and highways or separated from them by a buffer.

(2) Pedestrian Travel Along Streets and Highways

Examples of various types of pedestrian access routes are shown in Exhibit 1510-23. A generalized method of assessing the need for and adequacy of pedestrian facilities is shown in Exhibit 1510-24.

To determine what type of pedestrian facility to use, consider a study that addresses roadway classification, traffic speed, collision data, pedestrian generators, school zones, transit routes, and land use designation.

Chapter 1600 provides guidance on the design clear zone, based on various conditions.

(a) Basic Criteria for Pedestrian Accessible Routes

1. Surfacing

The surface of the pedestrian access route needs to be firm, stable, slip-resistant, and smooth. Use cement or asphalt concrete surfaces; crushed gravel is not considered to be a stable, firm surface.

Locate utility vaults and junction boxes outside the sidewalk. Where this is not practicable, use utility vaults and junction boxes with lids designed to reduce tripping and slipping (see the *Standard Plans*).

2. Vertical Clearance

Hanging or protruding objects within the walkway may present obstacles for pedestrians with visual impairments. The minimum vertical clearance for objects (including signs) overhanging a walkway is 7 feet (84 inches).

3. Horizontal Encroachment

The minimum clear width for an ADA pedestrian accessible route is 4 feet. Where the pedestrian access route is less than 5 feet wide, provide a 5-foot by 5-foot passing space at 200-foot intervals.

Fixtures located in the sidewalk are obstacles for pedestrians, and they reduce the clear width of the sidewalk. Provide a continuous, unobstructed route for pedestrians. When an unobstructed route is not possible, provide the minimum clear width for an accessible route around obstructions.

Objects that protrude more than 4 inches into the walkway are considered to be obstacles, and warning devices are necessary wherever feasible. Equip wall-mounted and post-mounted objects that protrude 4 inches or more into the walkway between 27 inches and 80 inches above the sidewalk with warning devices detectable by persons with impaired vision using a cane (see Exhibit 1510-1).

Where the walkway is located behind guardrail, address guardrail bolts or install a rub rail to prevent snagging. Consider the installation of “W” beam guardrail on the pedestrian side of the posts to reduce snagging and as a guide for sight-impaired pedestrians. Specify these construction requirements in the contract.

Provide a nonsnagging finish to vertical surfaces adjacent to a pedestrian facility to prevent snagging or abrasive injuries from accidental contact with the surface.

When relocation of utility poles and other fixtures is necessary for a project, determine the impact of their new location on all pedestrian walkways. Look for opportunities to eliminate obstructions, including existing utilities that obstruct the pedestrian route.

Acceptable Pedestrian Access Route

Unacceptable Pedestrian Access Route

Accessible Sidewalk

Sidewalk With Obstructions

Pedestrian Route Geometrics
Exhibit 1510-1

4. Geometrics of the Pedestrian Accessible Route

When considering both new and existing pedestrian-accessible routes, the geometric elements need to be evaluated for the running slope of the route, cross slope, width, amount of vertical rise over the length of the route, vertical differences at changes in surface grades (tripping hazards), and access across and through a vertical barrier (curb ramps).

(3) Shoulders

Paved shoulders are an extension of the roadway and are not considered pedestrian facilities; however, they can be used by pedestrians and may serve as a pedestrian access route. Although pedestrians are allowed to travel along the shoulder, its main purpose is to provide an area for disabled vehicles, a recovery area for errant vehicles, and positive drainage away from the roadway.

Determine whether the roadway shoulders are of sufficient width and condition to permit travel for pedestrians. Paved shoulders are preferable. A 4-foot-wide shoulder is acceptable where pedestrian activity is minimal and where school and other pedestrian generators are not present. Wider shoulders are desirable along high-speed highways, particularly when truck volumes or pedestrian activities are high.

Longitudinal travel along shoulders with cross slopes greater than 2% can be difficult for people with disabilities. Horizontal curves are usually superelevated and can have cross slopes steeper than 2%. The shoulders on these curves often have the same cross slope as the roadway. If pedestrians will use the shoulder frequently, consider a separate pedestrian access route.

(4) Shared-Use Paths

A shared-use path is a facility physically separated from motorized vehicular traffic within the highway right of way or on an exclusive right of way with minimal crossflow by motor vehicles. Primarily used by pedestrians and bicycles, shared-use paths are also used by joggers, skaters, wheelchair users (both nonmotorized and motorized), equestrians, and other nonmotorized users.

Chapter 1515 discusses the design elements and other design considerations of shared-use paths.

Shared-Use Path
Exhibit 1510-2

(5) Sidewalks

Plan the design of sidewalks carefully to include a pedestrian access route that provides universal access. Sidewalk design elements are found in Exhibits 1510-23 and 1510-27, and details for raised sidewalks are shown in the *Standard Plans*. Wherever appropriate, make sidewalks continuous and provide access to side streets. The most desirable installation for the pedestrian is a sidewalk separated from the traveled way by a planted buffer. This provides a greater separation between vehicles and pedestrians than curb alone.

(a) Buffers and Widths

Where a sidewalk is separated from the travelled way by only a curb, the WSDOT minimum sidewalk width is 6 feet, excluding the curb.

The WSDOT minimum width for a sidewalk is 5 feet, when used with a buffer at least 3 feet wide (see the *Standard Plans* and Exhibit 1510-23).

Sidewalk With Buffer
Exhibit 1510-3

Wider sidewalks are preferable in areas of high pedestrian traffic, such as a central business district and along parks, schools, and other major pedestrian generators. Coordinate with the city for appropriate sidewalk and buffer designs and funding participation in these cases.

Consider buffers of 4 feet for collector routes and 6 feet for arterial routes. If trees or shrubs are included, coordinate with the region or HQ Landscape Architect and refer to the *Roadside Manual*. Plants should not limit the visibility of motorists or pedestrians or pose obstructions on the pedestrian access route (see Chapter 1340). Design subsurface infrastructure (such as structural soils), and select plants whose root systems do not cause sidewalks to buckle or heave. Coordinate buffer planting with maintenance personnel.

In areas with snowfall, consider wider sidewalks or a sidewalk with a buffer to accommodate snow storage while keeping the pedestrian route free of snow accumulation. Make sure maintenance access is not obstructed.

Shoulders, bike lanes, and on-street parking are not considered buffers, but they do offer the advantage of further separation between vehicles and pedestrians.

(b) Alignment, Grade, and Cross Slope

Where the walkway (sidewalk) of a pedestrian access route is adjacent to a street, highway, or on a bridge, its running slope can match, but not exceed, the grade established for the adjacent roadway. On roadways with prolonged grades greater than 8.3%, consider providing hand railings,* level landings in line with the sidewalk, and rest areas adjacent to the level landings.

> **Sidebar:** **Guide for the Planning, Design, and Operation of Pedestrian Facilities*, AASHTO, 2004

Where the walkway (sidewalk or pedestrian circulation path) follows a separate and independent horizontal or vertical alignment from the street or highway, the running slope must comply with ADA standards. The maximum running slope allowed is 8.3%. (See Exhibit 1510-27 for the design element requirements for building and facilities ramps or independent walkways.)

Design sidewalks with cross slopes no more than 2%. Steeper cross slopes are difficult for people in wheelchairs to negotiate.

(c) Driveways

Driveways can be a barrier for persons with disabilities. Provide accessible crossings in locations where a sidewalk meets a driveway. An accessible route is 4 feet wide minimum with a cross slope of 2% or less. (See Exhibit 1510-4 for examples of driveway/sidewalk crossings.)

Consider limiting or consolidating driveways (vehicle access points). Construct driveways in accordance with ADA requirements, or provide an ADA accessible route. (See Chapter 520 for access control information and the *Standard Plans* for vehicle approach details and ADA requirements.) Where a driveway is present within the longitudinal limits of the sidewalk, provide a pedestrian-accessible route to maintain continuity along the sidewalk. (See Exhibit 1510-27 for design element requirements.)

Driveway/Sidewalk Crossings
Exhibit 1510-4

(d) Sideslopes, Railing, and Barriers

The sideslope adjacent to the sidewalk is a critical design element. Exhibit 1510-23 provides guidance on slope rounding and railings for various conditions. When there is a vertical drop-off of 2 feet 6 inches or more directly behind the sidewalk, provide a pedestrian railing when embankment widening is not possible (see Exhibit 1510-23).

The pedestrian railing is installed between the walkway and the vertical drop-off. Ensure pedestrian railing does not encroach on the sidewalk width.

Pedestrian railings are not always designed to withstand vehicular impacts or redirect errant vehicles. Chapter 1600 addresses the Design Clear Zone for vehicles.

Where the walkway is adjacent to a vertical drop-off and is separated from the roadway, consider installing the traffic barrier between the traveled way and the walkway. The pedestrian railing is installed between the walkway and the vertical drop-off.

(6) Curb Ramps (Sidewalk Ramps)

Curb ramps provide an accessible connection from a raised sidewalk down to the roadway surface. A curb ramp is required at the corners of all intersections where curbs and sidewalks are present, except where pedestrian crossing is prohibited. (See 1510.05(8)(b) and Exhibit 1510-7 for guidance on closed crossings.) For new construction, a curb ramp oriented in each direction of pedestrian travel aligned with the crosswalk it serves is required. For alterations, a separate curb ramp oriented in each direction of pedestrian travel aligned with the crosswalk it serves is required if possible. Every curb ramp must have a curb ramp at the other end of the crosswalk it serves unless there is no curb or sidewalk on the opposite side. Curb ramps are also required at midblock crossings where sidewalks are present.

(a) Types of Curb Ramps

Different types of curb ramps can be used: perpendicular, parallel, and combination. Wherever possible, it is desirable to provide a buffer around the corner to separate the sidewalk from the curb, allowing the curb ramp to be installed with curb returns that facilitate direction-finding for the visually impaired.

1. Perpendicular

This curb ramp is commonly used to provide access from the sidewalk to the street. The landing is to be located at the top of the curb ramp.

a. Advantages

- Ramp aligned with the crosswalk.
- Straight path of travel on tight radius.
- Two ramps per corner.

b. Disadvantages

- May not provide a straight path of travel on larger-radius corners.
- May not fit with the required flares on small-radius corners.

2. Parallel

This curb ramp works well in a narrower area with right of way limitations or where blending a curb ramp into steep grades is required. The landing is to be located at the bottom of the curb ramp.

a. Advantages

- Requires minimal right of way.
- Provides a level area that aligns with the crossing. The landing is contained in the sidewalk and not the street.
- Allows ramps to be extended to reduce ramp grade or blend into steep grades of sidewalk.
- Provides edges on the side of the ramp that are clearly defined for pedestrians with vision impairments.

b. Disadvantages

- Pedestrians need to negotiate two or more ramp grades, possibly making it more difficult to traverse.
- Improper design/construction of the landing can result in the accumulation of water or debris at the bottom of the ramp.

3. Combination

This combines the use of perpendicular and parallel types of curb ramps. The landing may be shared in this application.

a. Advantages

- Works well in areas where grades may be a problem.
- Does not require turning or maneuvering on the ramp.
- Ramp aligned perpendicular to the crosswalk.
- Level maneuvering area between ramps.
- Allows transition of running slopes in steep terrain.

b. Disadvantages

- Generally require more space.
- Might require more extensive alterations in retrofits.

(b) Curb Ramp Common Elements

To comply with ADA requirements, the following represents the design requirements for curb ramps:

1. Clear Width

- 4 feet wide minimum

2. Landings

A level landing is necessary at the top of a perpendicular ramp or the bottom of a parallel curb ramp as noted above for the type of curb ramp used. The top landing is provided to allow a person in a wheelchair room to maneuver into a position to use the ramp or bypass it. The lower landing allows a wheelchair user to transition from the ramp to the roadway crossing.

- The width of the landing matches the width of the curb ramp.
- In Preservation projects on existing landings, the length of the landing must be at least 3 feet.
- In new construction, provide a minimum 4-foot-square landing.
- When right of way constraints are not an issue, it is desirable to provide a larger landing.
- If the landing is next to a vertical wall, a 5-foot-wide clear area is desirable to allow a person in a wheelchair more room to maneuver and change directions.

- The running and cross slopes of landings for curb ramps on midblock crossings are permitted to be warped to meet street or highway grade.

3. **Running Slope**

   - Not to exceed 8.3% in new construction and Preservation projects.
   - The curb ramp maximum running slope shall not require the ramp length to exceed 15 feet.

4. **Cross Slope**

   - Not greater than 2%.

5. **Curb Ramp Flares**

   - Do not exceed 10%.

6. **Counter Slope**

   - Provide a counter slope of the gutter or street at the foot of the curb ramp or landing of 5% maximum. When the algebraic difference between the counter slope of the gutter or street and ramp running slope is equal to or greater than 11%, consider a 2-foot level strip at the base of the ramp (see Exhibits 1510-8 and 1510-27).

7. **Detectable Warning Surfaces**

   - Install where curb ramps or landings connect to a roadway.

Install detectable warning surfaces in all cases, including at channelizing islands (median and right-turn lanes as shown in Exhibit 1510-14). Detectable warning surfaces must contrast visually with the background material. ADAAG requires that detectable warnings "shall contrast visually with adjoining surfaces either light-on-dark or dark-on-light." WSDOT requires the use of federal yellow as the visual contrast on its projects. Other contrasting colors may be used on projects where cities have jurisdiction.

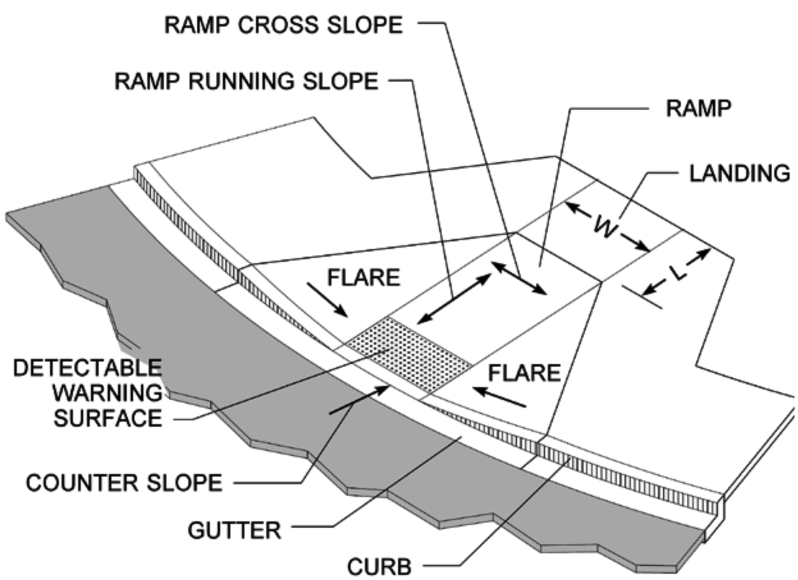
At signalized intersections, it is desirable to provide pedestrian push buttons on separate poles located near each curb ramp landing for ADA accessibility. Provide paved access to the pedestrian push button. (See Chapter 1330 for information on pedestrian guidelines at traffic signal locations.)

Perpendicular Ramps

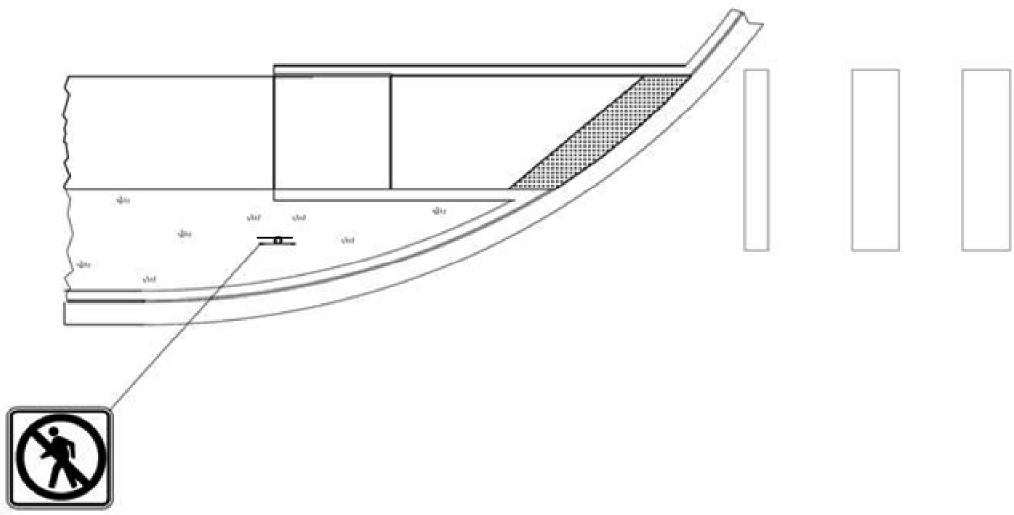
Parallel Ramp

Combination Ramp

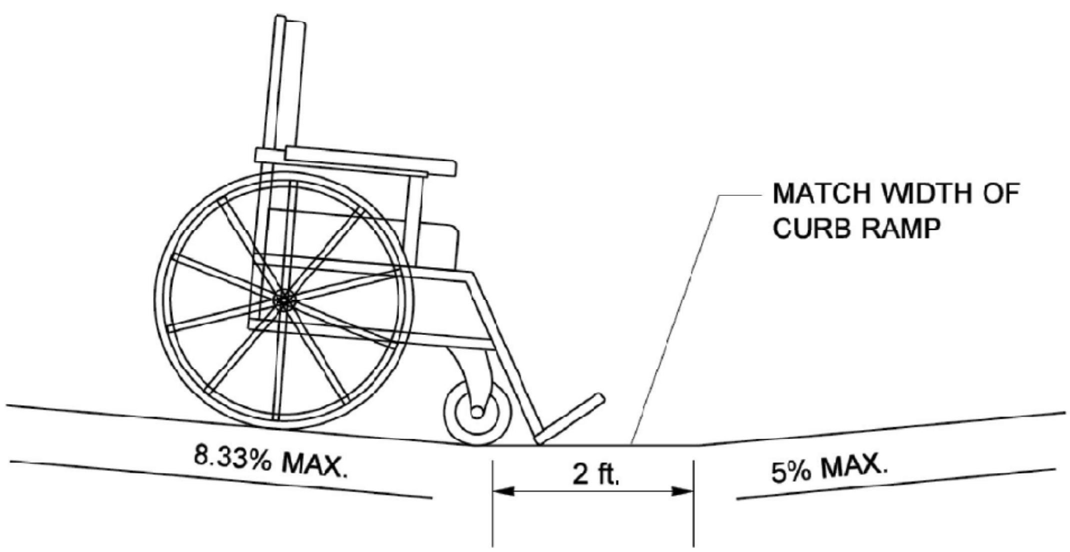
Curb Ramps
Exhibit 1510-5



Curb Ramp Common Elements
Exhibit 1510-6



Example of Closed Pedestrian Crossing
Exhibit 1510-7



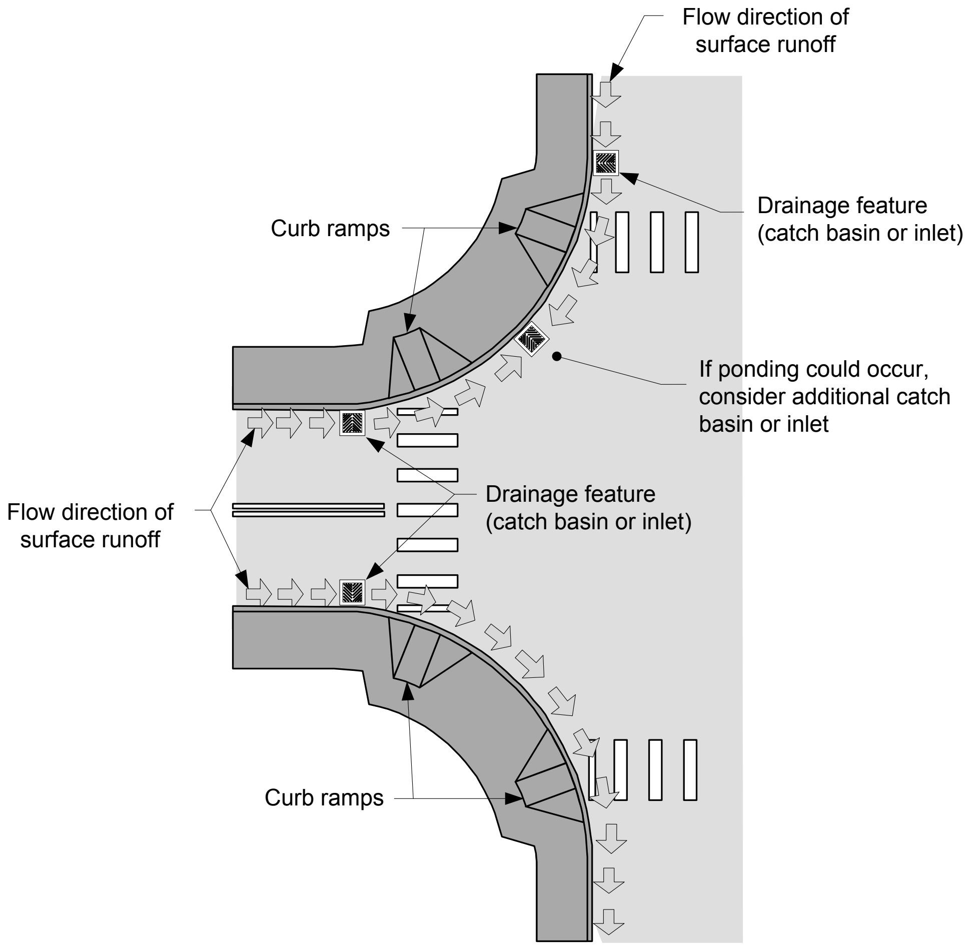
Consider a 2-foot level strip if algebraic difference ≥ 11%.

Source: *Guide for the Planning, Design, and Operation of Pedestrian Facilities,* AASHTO

Counter Slope Alternative
Exhibit 1510-8

(c) Curb Ramp Drainage

The lower terminus of the curb ramp is located at the beginning of a marked or unmarked crosswalk. Surface water runoff from the roadway can flood the lower end of a curb ramp. Determine the grades along the curb line and verify that the base of the curb ramp is not the lowest point of the gutter. Provide catch basins or inlets to prevent the flooding of the ramps. Exhibit 1510-9 shows examples of drainage structure locations. Verify that drainage structures will not be in the pedestrian access route.



Curb Ramp Drainage
Exhibit 1510-9

(7) Vehicle Bridges and Underpasses

Provide for pedestrians on vehicle bridges and underpasses where pedestrians are allowed (contact the HQ Bridge and Structures Office). Provide either raised sidewalks or ramps on the approaches to bridges that have raised sidewalks, pedestrian circulation paths, or shared-use paths. Design the ramp of either asphalt or cement concrete with a slope of 5% or less. These ramps can also be used as a transition from a raised sidewalk down to a paved shoulder. The ramp provides pedestrian access and mitigates the raised, blunt end of the concrete sidewalk for vehicles.

In underpasses where pedestrians are allowed, it is desirable to provide sidewalks and to maintain the full shoulder width. When bridge columns are placed on either side of the roadway, consider placing the walkway between the roadway and the columns for pedestrian visibility and security. Provide adequate lighting and drainage for pedestrian safety and comfort.

(8) Pedestrian Crossings at Grade

(a) Design Considerations for Crossing Facilities

Designing intersections for the needs of all users, including pedestrians, requires various considerations and tradeoffs. The following list presents design considerations for creating crossing facilities that meet pedestrians' needs:

- Minimize turning radii to keep speeds low. (See Chapter 1310 for design vehicle guidance.)
- Place crosswalks such that they are visible and adjacent to the pedestrian facility.
- Use a separate left-turn phase along with a "WALK/DON'T WALK" signal.
- Restrict or prohibit turns.
- Shorten crossing distance.
- Use a raised median for a pedestrian refuge in the median.
- Use pedestrian signals (APS).
- Use signage.
- Place crosswalks as close as practicable to the intersection traveled way.
- Provide pedestrian-level lighting.

(b) Closed Crossings

To meet ADA requirements, equal access to cross the highway shall be provided to all pedestrians unless pedestrian crossing is prohibited. Consult with the region Traffic Office when considering a prohibited crossing. Also:

- Provide an accessible alternative to the closed crossing.
- Make the leg on each side of the crossing inaccessible to all pedestrians.
- Install signs and a treatment that is detectable by persons with visual disabilities, restricting all pedestrians from crossing at that location (see Exhibit 1510-7).

All pedestrian crossings need to provide a pedestrian access route that meets ADA guidelines. Exhibit 1510-25 provides recommendations for determining pedestrian markings based on vehicular traffic volume and speed. Pedestrian crossings at grade are permitted along the length of most highways. Pedestrian crossing on all legs of an intersection is also permitted. An illegal pedestrian crossing only occurs when signs prohibit a particular crossing at an intersection or the crossing occurs between two adjacent signalized intersections (RCW 46.61.240).

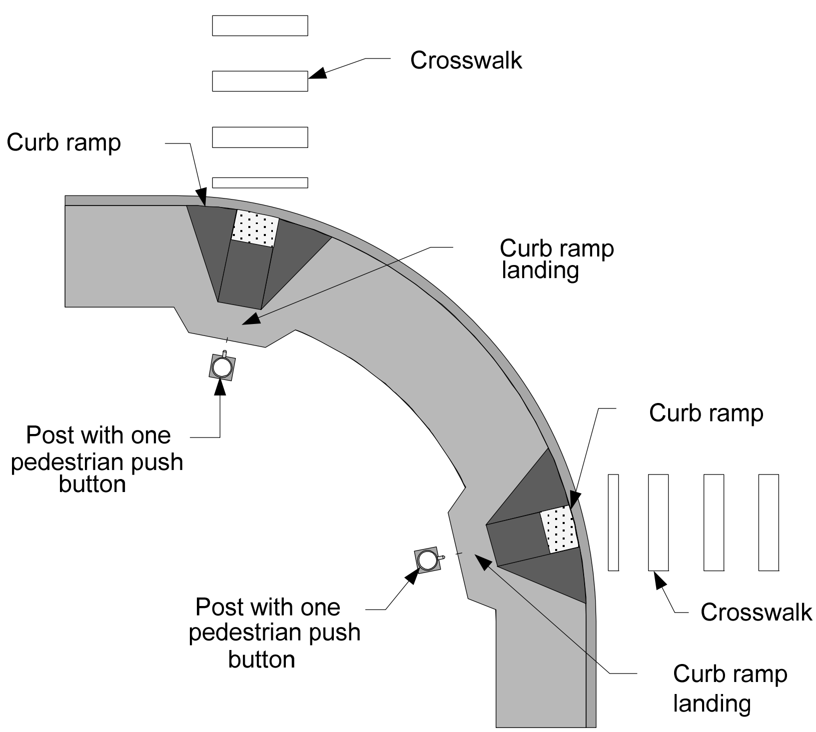
(c) Accessible Pedestrian Signals (APS)

Where there are pedestrian facilities, use ADA-compliant audible/vibrotactile pedestrian signals at all locations where pedestrian signals are newly installed or replaced. Consult with region and city maintenance personnel regarding maintenance requirements for these devices. Installation of these devices may require improvements to existing sidewalks and ramps to ensure ADA compliance. (See Chapter 1330 and the MUTCD for additional information.)

When designing pedestrian signals, consider the needs of older pedestrians and pedestrians with disabilities, as they might walk at a significantly slower pace than the average pedestrian. Determine whether there are pedestrian generators in the project vicinity that might attract older and disabled pedestrians. Adjust signal timing accordingly, and include countdown clocks where appropriate. Consult with region and city maintenance personnel regarding maintenance requirements for these devices.

- Locate pedestrian push buttons in accordance with Chapter 1330.
- Clearly identify which crossing is controlled by the push button.
- Provide a level surface at each push button for wheelchair users.
- Locate push button a maximum height of 3 feet 6 inches from level landing surface.*

*FHWA, *Designing Sidewalks and Trails for Access, Pedestrian-Actuated Traffic Controls*, 1999



Pedestrian Push Button Locations

Exhibit 1510-10

(9) Crosswalks at Intersections

Legal crosswalks, whether marked or not, exist at all intersections. An unmarked crosswalk is the 10-foot-wide area across the intersection behind a prolongation of the curb or edge of the through traffic lane (RCW 46.04.160). At roundabouts and intersections with triangular refuge islands or slip lanes (see Chapter 1310), the desired pedestrian crossings are not consistent with the definition of an unmarked crosswalk, and marked crossings are necessary. Inside city limits where the population exceeds 25,000, coordinate the decision to mark crosswalks with the city. WSDOT approves the installation and type only (RCW 47.24.020(13)). In unincorporated areas and within cities with populations less than 25,000, WSDOT has decision authority. WSDOT maintains decision authority in limited access areas. Coordinate with the city regardless of population.

The ADA requires that a pedestrian access route be provided at all marked and unmarked pedestrian crossings. This can be part or all of the crosswalk width. The accessibility criteria require a pedestrian access route within crosswalks of 4 feet minimum, with a running slope less than or equal to 5% and a cross slope less than or equal to 2% (see Exhibits 1510-26 and 1510-27).

Marked crosswalks are not to be used indiscriminately. They are used at signalized intersections, intersections with triangular refuge islands, and roundabouts so pedestrians know where they are to cross. Perform an engineering study before installing marked crosswalks away from highway traffic signals or stop signs. Note that the installation of a midblock pedestrian crossing on a state highway is a design deviation that requires approval and documentation. When considering a marked crosswalk, at a minimum evaluate the following factors:

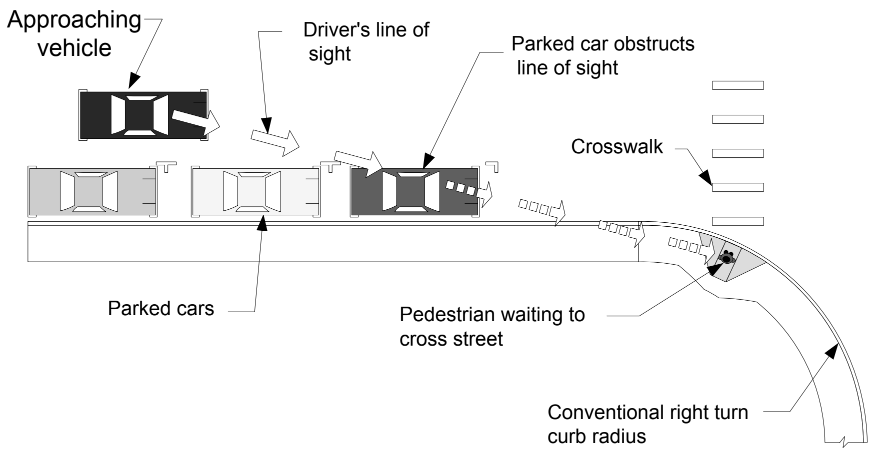
- The crosswalk would serve 20 pedestrians per hour during the peak hour, 15 elderly and/or children per hour, or 60 pedestrians total for the highest consecutive 4-hour period.
- The crossing is on a direct route to or from a pedestrian generator such as a school, library, hospital, senior center, community center, shopping center, park, employment center, or transit center (see the MUTCD). Generators in the immediate proximity of the highway are of primary concern. Pedestrian travel distances greater than ¼ mile do not generally attract many pedestrians.
- The local agency's comprehensive plan includes the development of pedestrian facilities in the project vicinity.
- The location is 300 or more feet from another crossing.
- Safety considerations do not preclude a crosswalk.

For marked crosswalks, the standard crosswalk marking consists of a series of wide white lines parallel with the longitudinal axis of the roadway. Crosswalk widths are at least 8 feet. A width of 10 feet is preferred in central business districts.* The lines are positioned at the edges and centers of the traffic lanes to place them out of the normal wheel path of vehicles. The preferred type of crosswalk is a longitudinal pattern known as a Ladder Bar, which is shown in the *Standard Plans*. Set back "stop" and "yield" lines to provide for sight distance to all approaches to an intersection. Stop and yield line dimensions and placement must conform to the MUTCD and are shown in the *Standard Plans*.

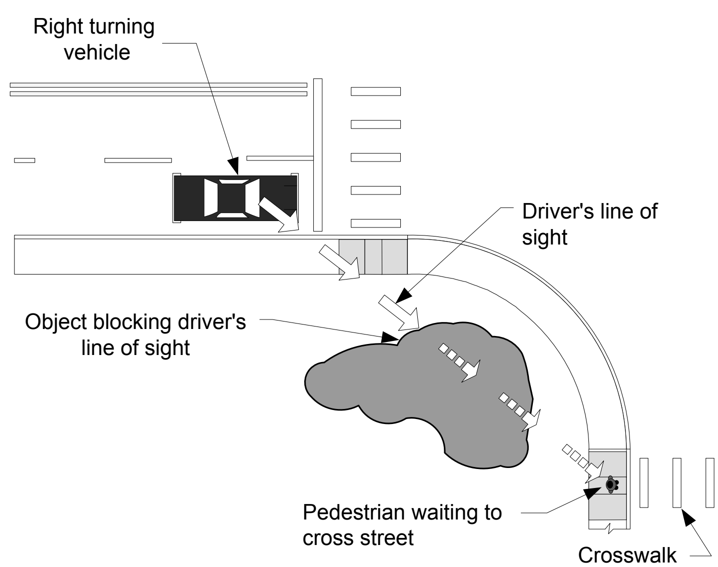
> **Sidebar:** **Guide for the Planning, Design, and Operation of Pedestrian Facilities*, AASHTO, 2004: 6 feet minimum, 10 feet desirable.
>
> *MUTCD crosswalks should be at least 6 feet wide.

Communities sometimes request specially textured crosswalks (such as colored pavement, bricks, or other materials). Consider that some textured materials may cause confusion for visually impaired pedestrians and can create discomfort for wheelchair users. These crosswalks do not always fall within the legal definition of a marked crosswalk, and parallel white crosswalk lines are recommended to enhance visibility and delineate the crosswalk. (See the MUTCD or the Local Agency Crosswalk Options website: www.wsdot.wa.gov/design/standards/plansheet/pm-2.htm.) Provide a nonslip surface on crosswalk markings appropriate for wheelchair use.

When locating crosswalks at intersections, consider the visibility of the pedestrian from the motorist's point of view. Shrubbery, signs, parked cars, and other roadside elements can block the motorist's view of the pedestrian. Exhibit 1510-11 illustrates these sight distance considerations.



Parked car blocking line of sight



Obstructed line of sight

Obstructed Line of Sight at Intersection

Exhibit 1510-11

(10) Midblock Crossings

On roadways with pedestrian crossing traffic caused by nearby pedestrian generators, consider a midblock pedestrian crossing. (See 1510.05(9) for crosswalk criteria and Exhibit 1510-25 for marked crosswalk recommendations at unsignalized intersections.) For midblock crossings, the pedestrian access route may have a cross slope that matches the running slope of the roadway (PROWAG R305.2.2.3). Note that the installation of a midblock pedestrian crossing on a state highway is a design deviation that requires ASDE approval and documentation. An example of a midblock crossing is shown in Exhibit 1510-12.

Midblock Pedestrian Crossing
Exhibit 1510-12

Conditions that might favor a midblock crossing include the following:

- Significant pedestrian crossing demand.
- Pedestrians fail to recognize the best or safest place to cross along a highway, and it is advisable to delineate the optimal location.
- The adjacent land use creates high concentrations of pedestrians needing to cross the highway at that location.
- The proposed crossing can concentrate or channel multiple pedestrian crossings to a single location.
- The crossing is at an approved school crossing on a school walk route.
- There is adequate sight distance for motorists and pedestrians.
- It is farther than 300 feet from an existing intersection.
- Speeds are less than 40 mph.

Consider the use of a warning beacon, as shown in Exhibit 1510-13.

Midblock Crossing With Beacon
Exhibit 1510-13

(11) Raised Medians/Traffic Islands

Wide, multilane streets are often difficult for pedestrians to cross, particularly when there are insufficient gaps in vehicular traffic because of heavy volumes. Consider the use of raised medians and traffic islands with a pedestrian refuge area (see Exhibit 1510-14) on roadways with the following conditions:

- Two-way multilane arterial with high speeds (above 45 mph), high average daily traffic (ADT), and large pedestrian volumes.
- Significant pedestrian collision history, especially near a school or other community center.
- Crossing distance exceeds 60 feet.
- Complex or irregularly shaped intersections.

The pedestrian access route through a raised median or traffic island can be either raised with curb ramps or a pass-through type (see Exhibit 1510-14). The edges of pass-throughs and curb ramps are useful as cues to the direction of a crossing. Consider this when designing an angled route through a median or island.

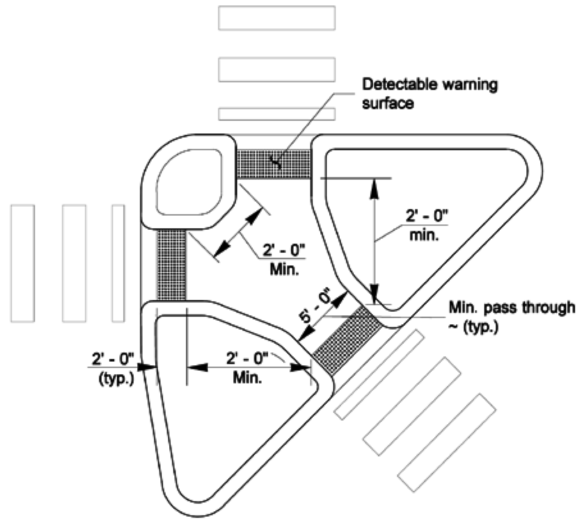
Curb ramps in medians and islands can add difficulty to the crossing for some users. There are many factors to consider when deciding whether to ramp up to the median or island grade or create a pass-through median or island matching the roadway grade. These factors may include profile grade and cross slope of the road, drainage and width, and length of the median or island.

The minimum pedestrian access route dimensions through a raised median or traffic island are shown in Exhibit 1510-14. This provides for a 2-foot detectable warning surface, 2 feet of pedestrian refuge, and 2 feet for another detectable warning surface. Lengths greater than the 6-foot minimum provide more refuge and pedestrian comfort. The width of the pedestrian access route is 5 feet minimum, with a running slope not to exceed 5% (with the exception of curb ramps, if used) and a cross slope not steeper than 2%. When the pedestrian access route of a shared-use path goes through a raised median or traffic island, the width should be the same as the shared-use path.

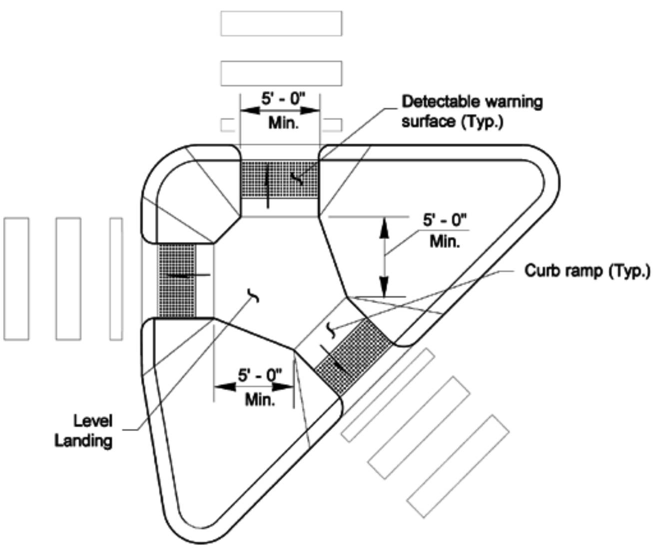
Detectable warning surfaces are located at each curb ramp or roadway entrance of a pedestrian access route through a raised median or traffic island. The detectable warning surface shall be located at the back of the curb line or at the edge of the roadway where there is no curb.

A traffic island used for channelized right-turn slip lanes can provide a pedestrian refuge, but may promote faster turning speeds. Minimize turning radii as much as possible to keep speeds as low as possible. To reduce conflicts, keep the slip lane as narrow as practicable and attempt to maintain a 90º crosswalk angle. (See Chapter 1310 for turn lanes, Chapter 1360 for interchange ramps, and Chapter 1320 for pedestrian accommodations in roundabouts.)

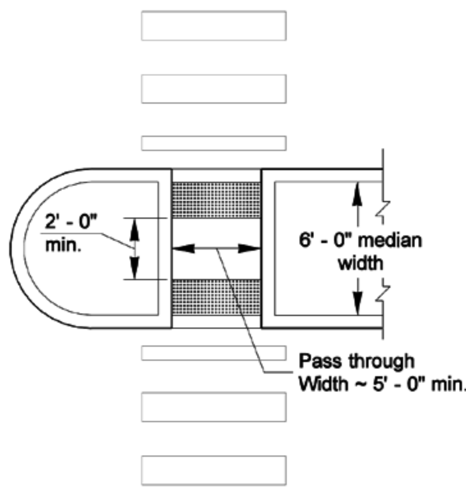
Island Pass-Through



Island Pass-Through



Raised Traffic Island With Curb Ramps



Median Island Pass-Through

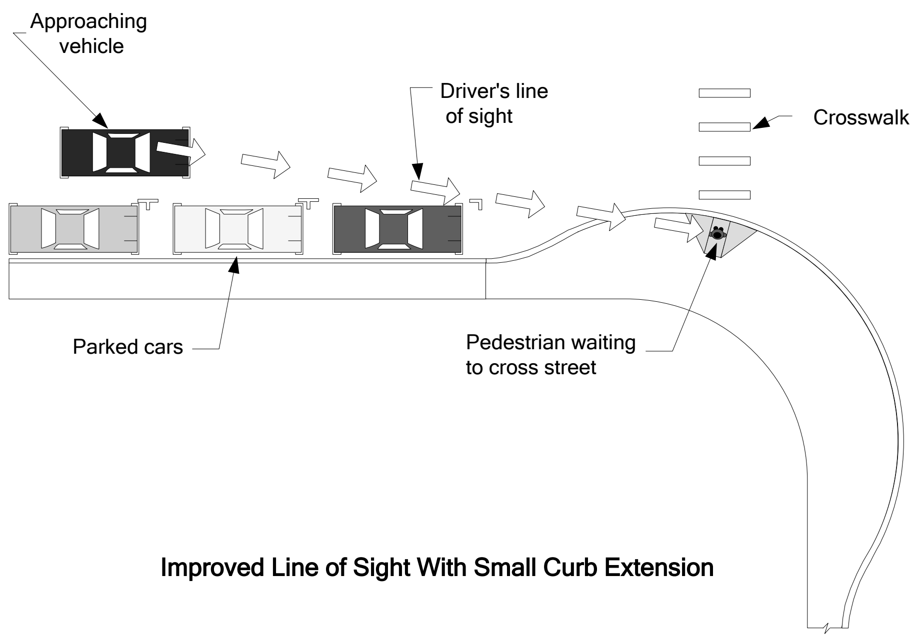
Raised Island With Pedestrian Pass-Through

Exhibit 1510-14

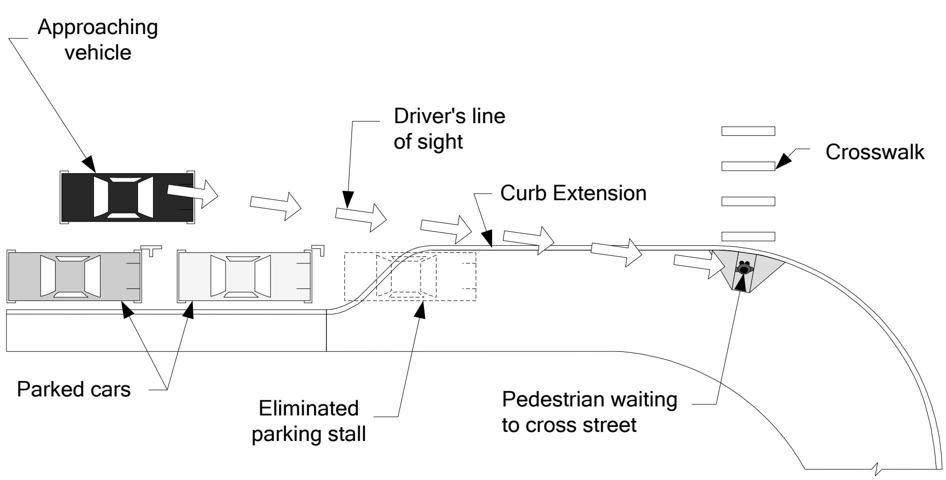
(12) Curb Extensions

Curb extensions are traffic calming measures that may improve sight distance and reduce pedestrian crossing times, which limits pedestrian exposure. Designing a curb extension will help eliminate the sight distance problem with parked cars that limit driver/pedestrian visibility. Curb extensions may allow for better curb ramp design.

Extend the curb no farther than the width of the parking lane. (See Chapter 1140 for shoulder width guidance.) Consider an approach nose and low-level landscaping that does not create a sight obstruction. At intersections with traffic signals, the curb extensions can be used to reduce pedestrian signal timing. Examples of sidewalk curb extensions are shown in Exhibits 1510-15 and 1510-16.



Improved Line of Sight With Small Curb Extension



Improved Line of Sight With Longer Curb Extension

Improved Line of Sight at Intersection

Exhibit 1510-15


Curb Extension Examples

Exhibit 1510-16

The right-turn path of the design vehicle or the vehicle most likely to make this turn is a critical element in determining the size and shape of the curb extension. Sidewalk curb extensions tend to restrict the width of the roadway and can make right turns difficult for large trucks.

Avoid interrupting bicycle traffic with curb extensions. Do not use curb extensions on state highways when:

- The design vehicle (see Chapter 1310) is required to encroach on curbs, opposing lanes, or same-direction lanes, and mountable curbs or other solutions will not improve the circumstances.
- Parking is not present.
- The posted speed is above 35 mph.

Plantings that do not obstruct the vision of pedestrians or drivers may be used within curb extension areas. Consider motorist and pedestrian visibility and Design Clear Zone guidelines (see Chapter 1600).

(13) Railroad Crossings at Grade

The design of pedestrian facilities across railroad tracks often presents challenges due to the conflicting needs of pedestrians and trains. In particular, the flangeway gap required for trains to traverse a crossing surface may create a significant obstacle for a person who requires a wheelchair, crutches, or walking aids for mobility. Whenever practicable, make crossings perpendicular to the tracks in order to minimize potential problems related to flangeway gaps (see Exhibit 1510-18). Crossing surfaces may be constructed of timber planking, rubberized materials, or concrete. Concrete materials generally provide the smoothest and most durable crossing surfaces. When detectable warning surfaces are used at railroad crossings, place them according to the stop line placement requirements in the MUTCD.

There are a number of railroad crossing warning devices intended specifically for pedestrian facilities (see the MUTCD). When selecting warning devices, consider such factors as train and pedestrian volumes, train speeds, available sight distance, number of tracks, and other site-specific characteristics. Coordinate with the HQ Design Office Railroad Liaison early in the design process so that all relevant factors are considered and agreement may be reached regarding design of warning devices and crossing surfaces.

Pedestrian Railroad Warning Device
Exhibit 1510-17

Except for crossings located within the limits of first-class cities,* the Washington Utilities and Transportation Commission (WUTC) must approve proposals for any new railroad at-grade crossings or changes to warning devices or geometry at existing crossings. Additionally, any project that requires the railroad to perform work such as installation of warning devices or crossings surfaces will require a railroad construction and maintenance agreement. Contact the HQ Design Office Railroad Liaison to coordinate with both WUTC and the railroad company.

*RCW 35.22.010: A first class city is a city with a population of ten thousand or more at the time of its organization or reorganization that has a charter adopted under Article XI, section 10, of the state Constitution.

There are few first-class cities in the state of Washington. Consult with the HQ Railroad Liaison.

Undesirable Recommended

Pedestrian Railroad Crossings
Exhibit 1510-18

1510.06 Pedestrian Facility Design: Grade Separations (Structures)

In extreme cases where there is a pedestrian collision history and the roadway, like freeways and other high-speed facilities, cannot be redesigned to accommodate pedestrians at grade, consider providing a separate pedestrian structure (see Exhibits 1510-19 and 1510-20). When considering a pedestrian grade-separation structure, determine whether the conditions that require the crossing are permanent. If there is a likelihood that pedestrians will not use a grade separation, consider less-costly solutions.

Locate the grade-separated crossing where pedestrians are most likely to cross the roadway. A crossing might not be used if the pedestrian is required to deviate significantly from a more direct route.

It is sometimes necessary to install fencing or other physical barriers to channel the pedestrians to the structure and reduce the possibility of undesired at-grade crossings. The HQ Bridge and Structures Office is responsible for the design of pedestrian structures.

Consider grade-separated crossings where:

- There is moderate-to-high pedestrian demand to cross a freeway or expressway.
- There are large numbers of young children, particularly on school routes, who regularly cross high-speed or high-volume roadways.
- The traffic conflicts that would be encountered by pedestrians are considered unacceptable (such as on wide streets with high pedestrian volumes combined with high-speed traffic).*

**Guide for the Planning, Design, and Operation of Pedestrian Facilities*, AASHTO, 2004

- The crossing conditions are extremely hazardous for pedestrians.
- There are documented collisions or close calls involving pedestrians and vehicles.
- One or more of the conditions stated above exists in conjunction with a well-defined pedestrian origin and destination (such as a residential neighborhood across a busy street from a school).*

(1) Pedestrian Bridges

Pedestrian grade-separation bridges (see Exhibit 1510-19) are more effective when the roadway is below the natural ground line, as in a "cut" section. Elevated grade separations, where pedestrians are required to climb stairs or use long approach ramps, tend to be underused. Pedestrian bridges require adequate right of way to accommodate accessible ramp approaches leading up to and off the structure. The bridge structure must comply with ADA requirements and shall meet the design requirements in Exhibit 1510-27 for either a pedestrian circulation path (5.0% or less) or a building and facilities ramp or independent walkway (between 5.01% and 8.3%).

For the minimum vertical clearance from the bottom of the pedestrian structure to the roadway beneath, see Chapter 720. This minimum height requirement can affect the length of the pedestrian ramp approaches to the structure. To comply with ADA requirements, the approaches to the pedestrian bridge are identified as either a pedestrian circulation path (5.0% or less) or a building and facilities ramp/ independent walkway (between 5.01% and 8.3%) and shall meet the requirements of 1510.07(2) and Exhibit

1510-27. When ramps are not feasible, provide both elevators and stairways. Stairways are to be designed in accordance with the following:
http://www.wsdot.wa.gov/Design/Standards/PlanSheet/RD-12.htm

Railings are provided on pedestrian bridges. Protective screening is sometimes desirable to deter objects from being thrown from an overhead pedestrian structure (see Chapter 720). The minimum clear width for pedestrian bridges is 8 feet.

Consider a clear width of 14 feet where a pedestrian bridge is enclosed or shared with bicycles or equestrians.

Pedestrian Bridges
Exhibit 1510-19

(2) Pedestrian Tunnels

Tunnels are an effective method of providing crossings for roadways located in embankment sections. Well-designed tunnels can be a desirable crossing for pedestrians. When possible, design the tunnel with a nearly level profile to provide complete vision from portal to portal (see Exhibit 1510-20). Some pedestrians may be reluctant to enter a tunnel with a depressed profile because they are unable to see whether the tunnel is occupied. Police officers also have difficulty patrolling depressed profile tunnels. (See Exhibit 1515-27, Building and Facilities Ramp or Independent Walkway, for pedestrian access route parameters.)

Provide vandal-resistant daytime and nighttime illumination within the pedestrian tunnel. Installing gloss-finished tile walls and ceilings can also enhance light levels within the tunnel. The minimum overhead clearance for a pedestrian tunnel is 10 feet. The minimum width for a pedestrian tunnel is 12 feet. Consider a tunnel width between 14 and 18 feet depending on usage and the length of the tunnel.

Pedestrian tunnels require adequate right of way to accommodate accessible ramp approaches leading to the tunnel structure. The tunnel structure must comply with ADA requirements and shall meet the design requirements in Exhibit 1510-27 for either a pedestrian circulation path (5% max) or a building and facilities ramp (between 5.01% and 8.3%).

The approaches to the pedestrian tunnel are identified as either a pedestrian circulation path (5% max) or a building and facilities ramp (between 5.01% and 8.3%) and shall comply with ADA requirements as outlined in 1510.07(2) and Exhibit 1510-27.

Pedestrian Tunnel
Exhibit 1510-20

1510.07 Other Pedestrian Facilities

(1) Transit Stops and School Bus Stops

The location of transit stops is an important consideration in providing appropriate pedestrian facilities. (Coordinate with the local transit provider.) Newly constructed transit stops must conform to ADA requirements (see Chapter 1430). On new construction, design the transit stop such that it is accessible from the sidewalk or paved shoulder. A transit stop on one side of a street usually has a counterpart on the opposite side because transit routes normally function in both directions on the same roadway. Provide adequate crossing facilities for pedestrians.

When locating transit stops, consider transit ridership and land use demand for the stop. Also, consider compatibility with the following roadway/traffic characteristics:

- ADT
- Traffic speed
- Crossing distance
- Collision history
- Sight distance
- Connectivity to a pedestrian access route
- Traffic generator density

If any of these suggests an undesirable location for a pedestrian crossing, consider a controlled crossing or another location for the transit stop.

When analyzing locations with high pedestrian collision rates, consider the presence of nearby transit stops and opportunities for pedestrians to reasonably safely cross the street. At-grade midblock pedestrian crossings may be effective at transit stop locations on roadways with lower vehicular volumes. Pedestrian grade separations are appropriate at midblock locations when vehicular traffic volumes prohibit pedestrian crossings at grade. (See Exhibit 1510-25 for recommendations for marked crosswalks at unsignalized intersections.)

School bus stops are typically adjacent to sidewalks in urban areas and along shoulders in rural areas. Determine the number of children using the stop and provide a waiting area that allows the children to wait for the bus. Coordinate with the local school district. Because of their smaller size, children might be difficult for motorists to see at crossings or stops. Determine whether utility poles, vegetation, and other roadside features interfere with the motorist's ability to see the children. When necessary, remove or relocate the obstructions or move the bus stop. Parked vehicles can also block visibility, and parking prohibitions might be advisable near the bus stop.

(2) Access Ramps Within Transit Stops, Park & Ride Lots, Rest Areas, Buildings, and Other Facilities

An access ramp (see Exhibit 1510-21) provides an accessible pedestrian route from a sidewalk or pedestrian circulation path to a facility such as a transit stop, park & ride lot, rest area, pedestrian overcrossing/undercrossing structure, or building. When the running slope is 5% or less, it is a pedestrian circulation path; when the running slope is greater than 5% to a maximum of 8.3% (between 5.01 % and 8.3%), it is a building and facilities ramp. (See Exhibit 1510-27 for the design requirements.)

- Provide a running slope of 8.3% or less on newly constructed pedestrian access ramps. The cross slope is not to exceed 2%.
- The minimum clear width of ramps is 3 feet; however, it is desirable to match the width of the connecting pedestrian facility.
- Do not exceed 2 feet 6 inches on the vertical rise of ramps between landings.
- Provide landings at the top and bottom of each access ramp run.
- Provide handrails on all ramp runs with a rise greater than 6 inches.

Match ramp landing widths to the widest ramp entering the landing. Landings must have a minimum clear length of 5 feet with a 2% maximum cross slope. If a change in direction is needed, a 5-foot x 5-foot landing is required (see Exhibit 1510-27).

Pedestrian Access Ramp

Exhibit 1510-21

1510.08 Illumination and Signing

In Washington State, the highest number of collisions between vehicles and pedestrians occur during November through February when there is poor visibility and fewer daylight hours. Illumination of pedestrian crossings and other walkways is an important design consideration because lighting has a major impact on a pedestrian's safety and sense of security. Illumination provided solely for vehicular traffic is not always effective in lighting parallel walkways for pedestrians. Consider pedestrian-level (mounted at a lower level) lighting for walkways, intersections, and other pedestrian crossing areas with high nighttime pedestrian activity, such as shopping districts, transit stops, schools, community centers, and other major pedestrian generators or areas with a history of pedestrian collisions. (See Chapter 1040 for design guidance on illumination and Chapter 1020 and the MUTCD for pedestrian-related signing.)

1510.09 Work Zone Pedestrian Considerations

Providing access and mobility for pedestrians through and around work zones is an important design concern and must be addressed in the temporary traffic control plans if the project occurs in a location accessible to pedestrians. The designer must determine pedestrian needs in the proposed work zone during the public process and through field visits. In work zones:

- Separate pedestrians from conflicts with work zone equipment and operations.
- Separate pedestrians from traffic moving through or around the work zone.
- Provide pedestrians with alternate routes that have accessible and convenient travel paths duplicating, as closely as feasible, the characteristics of the existing pedestrian facilities.

Provide walkways that are clearly marked and pedestrian barriers that are continuous, nonbendable, and detectable to persons with impaired vision using a cane. Also, keep:

- The pedestrian head space clear.
- Walkways free from pedestrian hazards such as holes, debris, and abrupt changes in grade or terrain.
- Access along sidewalks clear of obstructions such as construction traffic control signs.
- A minimum clear width path throughout: 4 feet for pedestrians or 10 feet for pedestrians and bicyclists.

Temporary pedestrian facilities within the work zone must meet accessibility criteria (see Exhibits 1510-22 and 1510-27).

Consider the use of flaggers if pedestrian generators such as schools are in the work zone vicinity. Consider spotters prepared to help pedestrians through the work zone.

Provide the requirement of advance public notification of sidewalk closures in the contract special provisions and plans.

Where transit stops are affected or relocated because of work activity, provide an accessible route to temporary transit stops.

For further information or guidance on work zone pedestrian considerations, see Chapter 1010 and the MUTCD.

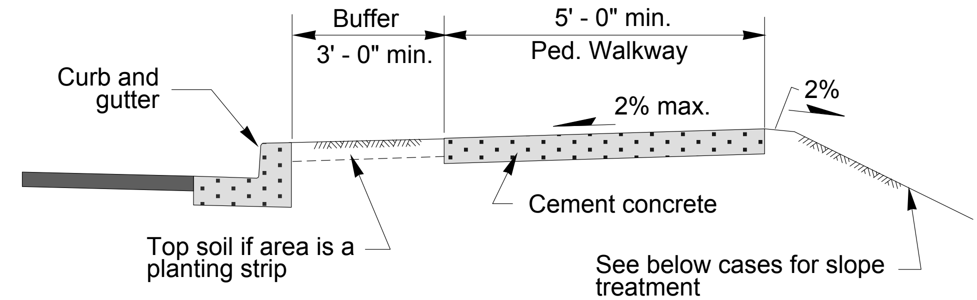
Meets ADA Requirements

Does Not Meet ADA Requirements

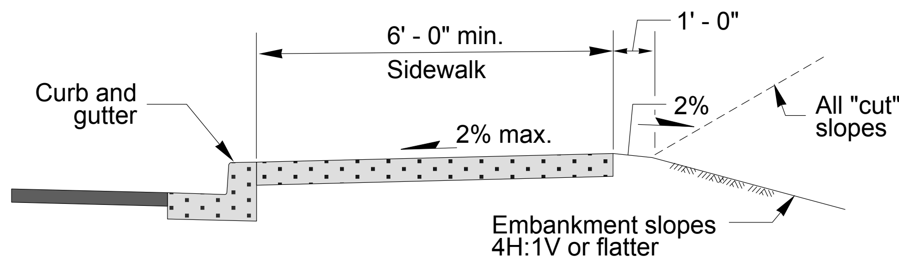
Work Zones and Pedestrian Facilities
Exhibit 1510-22

1510.10 Documentation

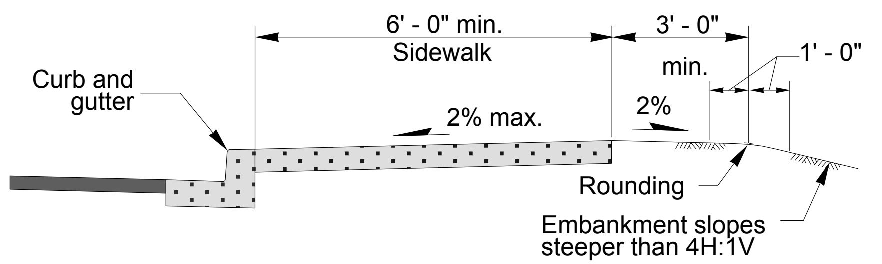
For the list of documents required to be preserved in the Design Documentation Package and the Project File, see the Design Documentation Checklist:
www.wsdot.wa.gov/design/projectdev/



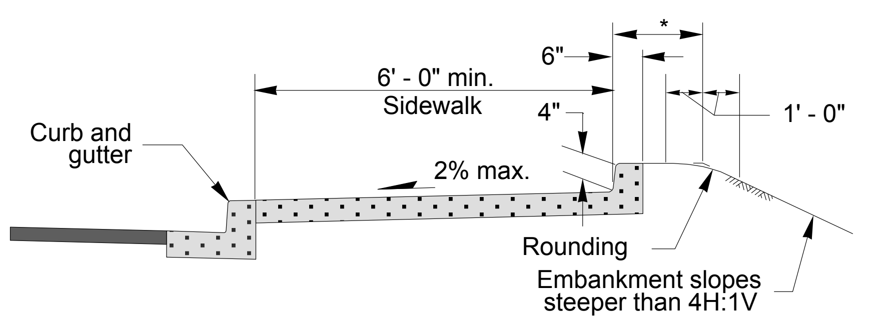
Case A



Case B



Case C

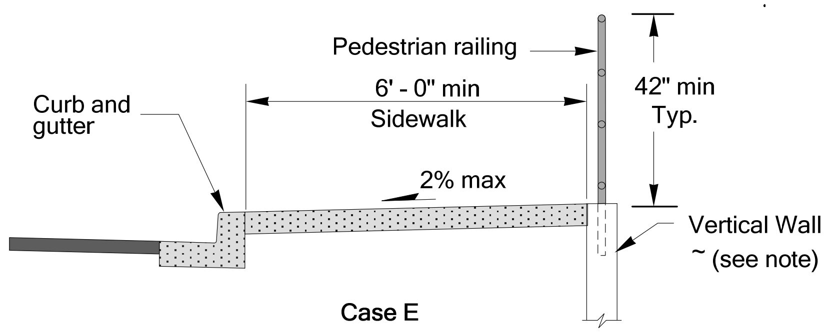


Case D

*See the *Standard Plans*.

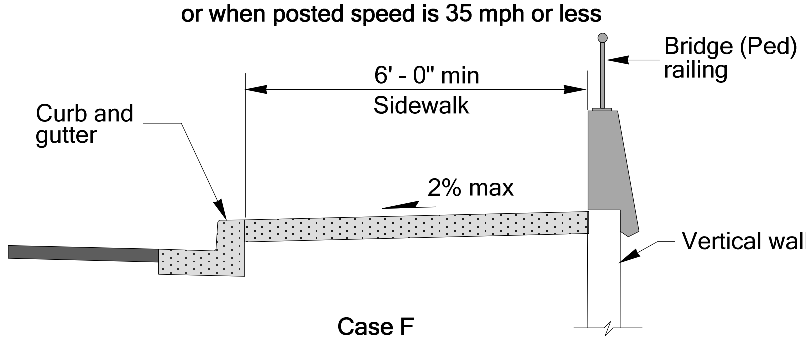
Pedestrian Access Routes

Exhibit 1510-23



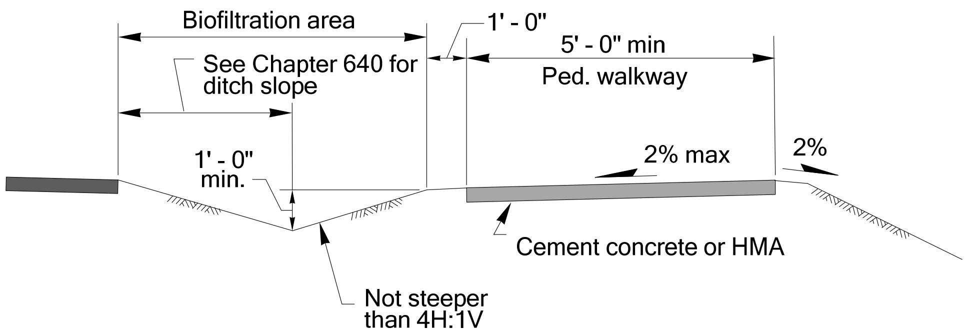
Case E

When the wall is outside the Design Clear Zone
or when posted speed is 35 mph or less

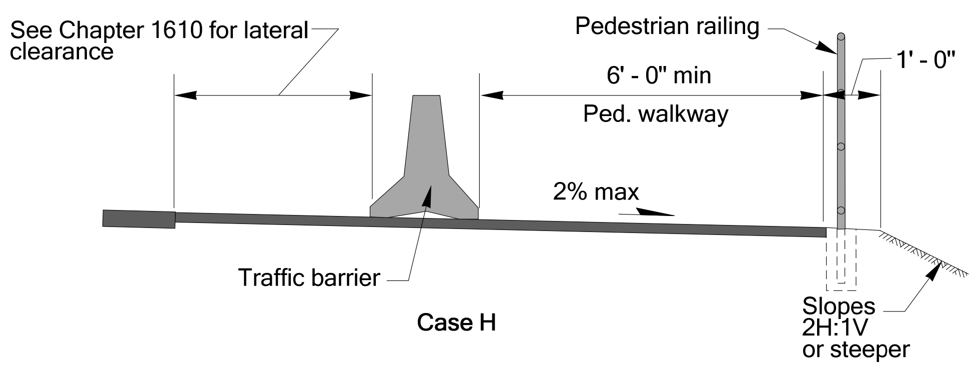


Case F

When the wall is within the Design Clear Zone



Case G



Case H

Notes for Case E:

- If vertical drop is >2 feet 6 inches, railing is indicated.
- If vertical drop is < 2 feet 6 inches, a 4-inch curb is adequate.

Pedestrian Access Routes

Exhibit 1510-23 (continued)

Roadway Classification and Land Use Designation	Sidewalk Recommendations					
			Desirable		Recommended	
	No sidewalk recommended	4-foot-wide paved shoulders adequate	Sidewalk on one side	Sidewalks on both sides	Sidewalk on one side	Sidewalks on both sides
Rural highways/interchanges outside urban growth areas	X[1]	X[1]				
Suburban highways with 1 or less dwelling unit per acre		X	X			
Suburban highways with 2–4 dwelling units per acre				X	X	
Major arterial in residential area						X
Collector or minor arterial in residential area						X
Local street in residential area with less than 1 dwelling unit per acre		X	X			
Local street in residential area with 1–4 dwelling units per acre				X	X	
Local street in residential area with more than 4 dwelling units per acre						X
Streets in commercial area						X
Streets in industrial area				X	X	

Note:
[1] Consider an engineering study to identify a need.

Sidewalk Recommendations

Exhibit 1510-24

Traffic Volume (ADT)	Posted Speed	Roadway Type			
		2 lanes	2 lanes, raised median[1]	4 lanes, raised median[1]	6 lanes, raised median[1]
Less than or equal to 9,000	30 mph and lower	Marked crosswalk	Marked crosswalk	Additional enhancement	
	35 mph to 40 mph	Marked crosswalk	Marked crosswalk	Additional enhancement	
	45 mph and higher	Additional enhancement	Additional enhancement	Active enhancement	
9,000 to 15,000	30 mph and lower	Marked crosswalk	Marked crosswalk	Additional enhancement	
	35 mph to 40 mph	Marked crosswalk	Marked crosswalk	Additional enhancement	
	45 mph and higher	Additional enhancement	Additional enhancement	Active enhancement	
15,000 to 30,000	30 mph and lower	Additional[2] enhancement	Additional enhancement	Additional[2] enhancement	Active[4] enhancement
	35 mph to 40 mph	Additional[2] enhancement	Additional enhancement	Active enhancement	Active[4] enhancement
	45 mph and higher	Active[5] enhancement	Active enhancement	See note[3]	See note[3]
Greater than 30,000	45 mph and lower	Active[5] enhancement	Active enhancement	Pedestrian[6] traffic signal	Pedestrian[6] traffic signal

Inside city limits where the population exceeds 25,000, the decision to mark crosswalks resides with the city, subject to WSDOT approval of the installation and type. Provide documentation for all marked crosswalks.

For additional considerations that may be appropriate based on site-specific engineering analyses, see 1510.05(3).

Notes:

[1] Raised median/traffic island with a pass-through path minimum width of 5 feet and a median width of 6 feet.

[2] Consider active enhancement treatment for roadways exceeding 20,000 ADT.

[3] Provide alternate routes for pedestrian crossings or construct a grade-separated facility.

[4] Location may be approaching the need for a controlled crossing. A pedestrian signal may be appropriate, based on engineering analysis.

[5] Raised median/traffic island required.

[6] Refer to region Traffic Engineer for approval and design of a pedestrian traffic signal. Midblock pedestrian crossings are deviations that require ASDE approval.

Minimum Guidelines (additive for each level):

“Marked crosswalk”

- Marked/signed in accordance w/MUTCD (signed @ crossing only)
- Pedestrian-view warning signs
- Illumination

“Additional enhancement”

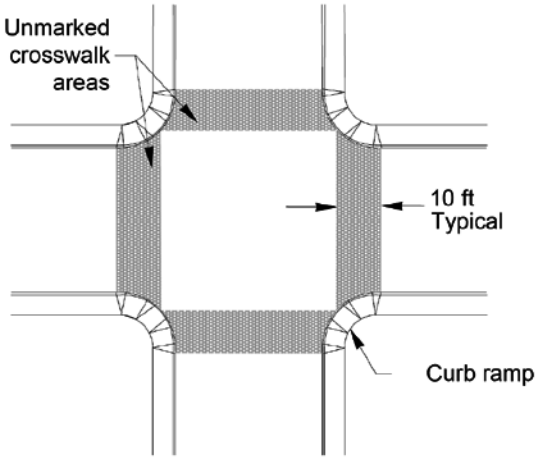
- Minimum guidelines listed under “Marked crosswalk”
- Stop line in accordance w/MUTCD
- Advance signing in accordance w/MUTCD

“Active enhancement”

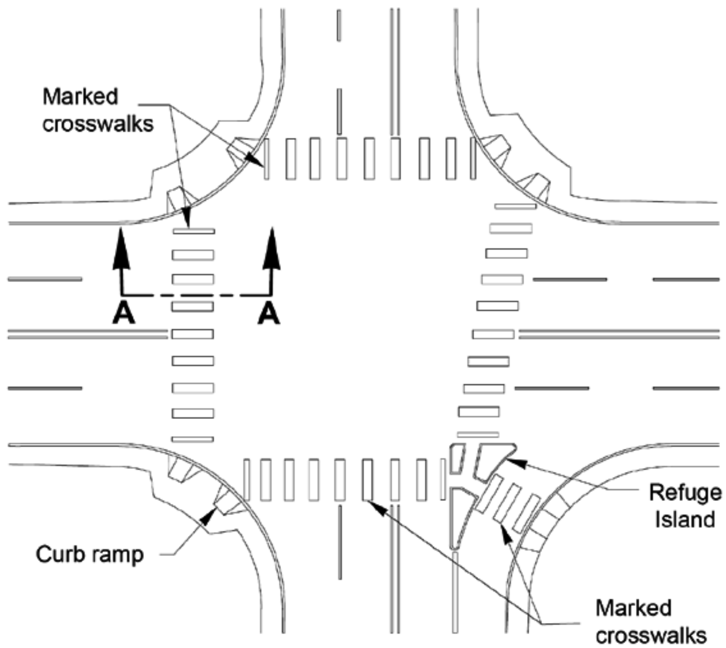
- Minimum guidelines listed under “Additional enhancement”
- Pedestrian-actuated warning beacons—overhead for roadway with 4 or more lanes

Crosswalk Guidelines

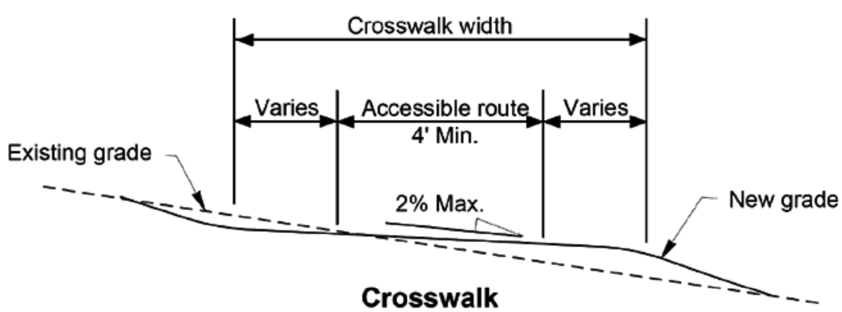
Exhibit 1510-25



Unmarked Crosswalks



Marked Crosswalk



Crosswalk

Section A - A

Crosswalks and Pedestrian Access Route Cross Slope

Exhibit 1510-26

Design Element / Design Feature	Curb Ramp	Sidewalk	Driveway Crossing	Crosswalk	Landing	Crossing Through Island/Median	Pedestrian Circulation Path[14]	Building and Facilities Ramp <u>or Independent Walkway</u> [1][2][14]
Clear Width	4 ft Min [1510.05(6)]	4 ft Min for accessible route within sidewalk width[3][5] [1510.05(5)]	4 ft Min – See Std Plans	4 ft Min for accessible route within crosswalk[4] [1510.05(8),(9),(10)]	See **Curb Ramp** or **Building and Facilities Ramp** requirements	Pass-through: 5 ft Min – Island: 6 ft Min [1510.05(11)]	4 ft Min[5] [1510.05(2)]	At least the width of widest ramp run connected to landing – 3 ft Min
Cross Slope	2% Max [1510.05(6)]	2% Max [1510.05(5)]	2% Max – See Std Plans	2% Max for accessible portion	2% Max	2% Max	2% Max	2% Max
Running Slope	8.3% Max[7] [13] [1510.05(4)]	5% Max[6] [1510.05(5)]	See Note 6 [1510.05(5)]	5% Max	2% Max	5% Max [1510.05(11)] If curb ramp is used, see **Curb Ramp** requirements	5% Max[6] [1510.05(2)]	<u>Above 5% to</u> 8.3% Max[7]
Maximum Vertical Rise	N/A	N/A	N/A	N/A	N/A	N/A	<u>N/A</u>	Landing every 2.5 ft vertical rise [1510.07(2)]
Grade Break	Flush – See Std Plans	Flush	½ inch between roadway gutter & curb	Flush	Flush	Flush	Flush	Flush
Surface Discontinuities	N/A	**New:** Flush **Existing:** See Note 8	N/A	N/A	N/A	N/A	**New:** Flush **Existing:** See Note 8	**New:** Flush **Existing:** See Note 8
Curb Flare Slope	10% Max	N/A	10% Max[9]	N/A	N/A	If curb ramp is used, see **Curb Ramp** requirements	N/A	N/A
Horizontal[12] Encroachment	4 inches Max [1510.05(2)(a)(3)]	4 inches Max	4 inches Max	4 inches Max	4 inches Max	4 inches Max	4 inches Max	4 inches Max

U.S. Access Board Accessibility Requirements for Pedestrian Facility Design
(For WSDOT guidance, see referenced chapter sections in table)
Exhibit 1510-27

Design Element / Design Feature	Curb Ramp	Sidewalk	Driveway Crossing	Crosswalk	Landing	Crossing Through Island/Median	Pedestrian Circulation Path[14]	Building and Facilities Ramp or Independent Walkway[1][2][14]
Vertical Clear Area	80 inches Min[10] [1510.05(2)]	80 inches Min[10] [1510.05(2)]	80 inches Min[10]	80 inches Min[10]	80 inches Min[10]	80 inches Min[10]	80 inches Min[10]	80 inches Min[10]
Counter Slope	5% Max [1510.05(6)]	N/A	N/A	See **Curb Ramp**	N/A	N/A	N/A	N/A
Landing	Width: Min match curb ramp width Length: **New:** 4 ft min **Alteration:** 3 ft [1510.05(6)]	N/A	N/A	– – – –	– – – –	N/A unless a curb ramp is used – See **Curb Ramp** requirements	N/A	Level landing required for every 2.5 ft vertical rise – Match landings to the width of the widest ramp leading into the landing[11]
Detectable Warning Surface	2 ft wide, 6 inches behind face of curb, full width of ramp	N/A	N/A	N/A	N/A	2 ft wide, each side, 6 inches behind face of curb, full width of opening	2 ft wide, full width when path joins roadway shoulder	N/A

Notes:

[1] A ramp with a rise greater than 6 inches in this context is on a walkway on a separate alignment that is not adjacent to or parallel to a roadway; ramps may have slopes greater than 5% and 8.3% max.

[2] Ramps with a rise greater than 6 inches. Also, ramps require edge protection and shall have handrails.

[3] Required sidewalk width: 5 ft where buffer is included, 6 ft when sidewalk is next to curb.

[4] Unmarked crosswalks require a 10 ft wide area across intersection. Marked crosswalks are required to be 8 ft min., 10 ft desirable. (See RCW 46.04.160 and the MUTCD for crosswalks.)

[5] If less than 5 ft wide, provide 5 ft x 5 ft passing areas every 200 ft.

[6] Allowed to match the roadway grade when located adjacent to and parallel to the roadway; landings would not be required.

[7] For Preservation projects: 10% to 8.33% for rises to 6 inches; 12.5% to 10% for rises to 3 inches.

[8] Changes in level of ¼ inch max are allowed to be vertical; changes between ¼ inch and ½ inch max to be beveled at 2H:1V.

[9] Required when sidewalk is provided behind the driveway.

[10] 7 ft min. vertical clearance required to bottom of signs (see the MUTCD and the *Standard Plans*).

[11] Change of direction requires 5 ft x 5 ft landing.

[12] Shall not reduce the clear width required for pedestrian access routes.

[13] The curb ramp maximum running slope shall not require the ramp length to exceed 15 feet.

[14] For additional shared-use path information, see Chapter 1515.

U.S. Access Board Accessibility Requirements for Pedestrian Facility Design
(For WSDOT guidance, see referenced chapter sections in table)
Exhibit 1510-27 (continued)

1515.01 General

The Americans with Disabilities Act of 1990 (ADA) requires that pedestrian facilities be designed and constructed such that they are readily accessible and usable by individuals with disabilities. Because shared-use paths include pedestrians, accessibility requirements apply. Design shared-use paths in accordance with this chapter.

Some common locations for shared-use paths are along rivers, streams, ocean beachfronts, canals, utility rights of way, and abandoned railroad rights of way; within college campuses; and within and between parks. Another common application of shared-use paths is to close gaps in bicycle networks. There might also be situations where such facilities can be provided as part of planned developments.

Shared-use paths often provide recreational opportunities. They also serve to minimize motor vehicle interference by providing direct commute routes for path users.

Design shared-use paths and roadway crossings in consultation with your region's ADA Coordinator and Bicycle Coordinator. For additional information on pedestrian and bicycle facilities, see Chapters 1510 and 1520, respectively.

1515.02 Definitions

shared-use path A facility physically separated from motorized vehicular traffic within the highway right of way or on an exclusive right of way with minimal crossflow by motor vehicles. Primarily used by pedestrians and bicyclists, shared-use paths are also used by joggers, skaters, wheelchair users (both nonmotorized and motorized), equestrians, and other nonmotorized users.

rest area An area to the side of the path.

running slope A slope measured in the direction of travel, normally expressed as a percent.

landing A level (0 to 2% grade in any direction) paved area within the shared-use path, designed to provide turning and maneuvering space for wheelchair users and as a resting place for pedestrians.

1515.03 Shared-Use Path Design

When designing shared-use paths (see Exhibit 1515-1), the bicycle may not be the critical design user for every element of design. For example, the crossing speeds of most intersections between roads and pathways should be designed for pedestrians, as they are the slowest users. Accommodate all intended users and minimize conflicts. When designing to serve equestrians, provide a separate bridle trail along the shared-use path to minimize conflicts with horses.

Shared-Use Path
Exhibit 1515-1

(1) Design Speed

The design speed for a shared-use path is based on the bicycle user and is dependent on the terrain and the expected conditions of use. Design the path to encourage bicyclists to operate at speeds compatible with other users. Maintain speeds at or below the speeds shown in Exhibit 1515-2. Higher speeds are inappropriate in a mixed-use setting.

Conditions	Design Speed (mph)	Minimum Curve Radius (ft)
Open country (level or rolling); shared-use path in urban areas	20	90
Long downgrades (steeper than 4% and longer than 500 ft)	30	260

Bicycle Design Speeds
Exhibit 1515-2

(2) Widths

The desirable paved width of a shared-use path is 12 feet. The minimum paved width is 10 feet. The provision of 12- to 14-foot paved paths is desirable when substantial use by both pedestrians and bicyclists is expected or maintenance vehicles are anticipated. Shoulders are typically unpaved and are to be at least 2 feet wide. (See Exhibits 1515-3 and 1515-4 for additional information and cross sections.)

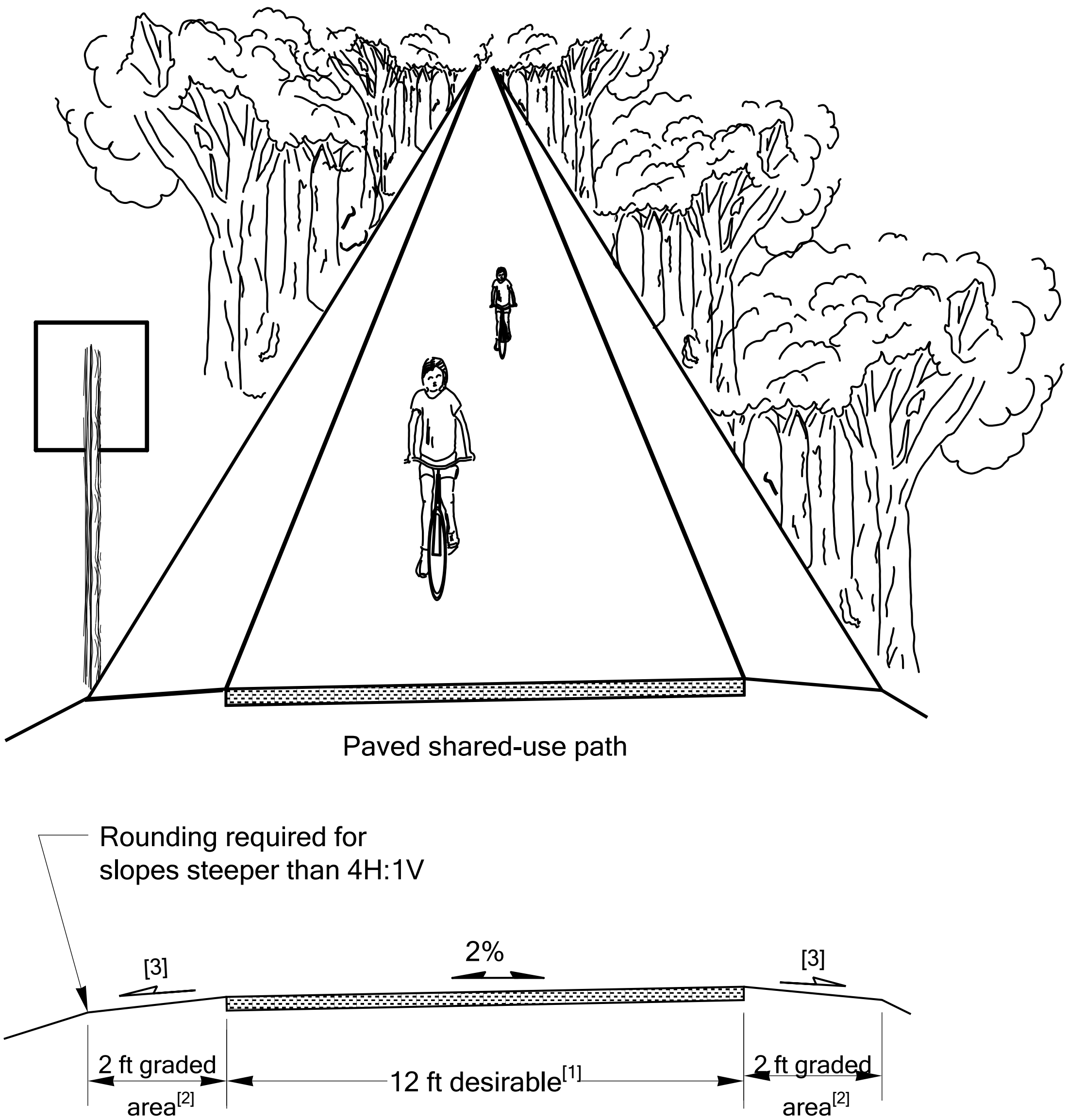
An existing path with a width of 8 feet may remain when all of the following conditions apply:

- Bicycle traffic is low.
- Pedestrian use is low.
- The horizontal and vertical alignments provide frequent passing opportunities.
- Normal maintenance activities can be performed without damaging the pavement edge.

For path width on structures, see 1515.03(15).

(3) Cross Slope

The maximum cross slope, including superelevation, on a shared-use path is 2%. Avoid crown. A cross slope greater than 2% can cause maneuvering difficulties for adult tricyclists and wheelchair users (see Exhibits 1515-3 and 1515-4).



Notes:

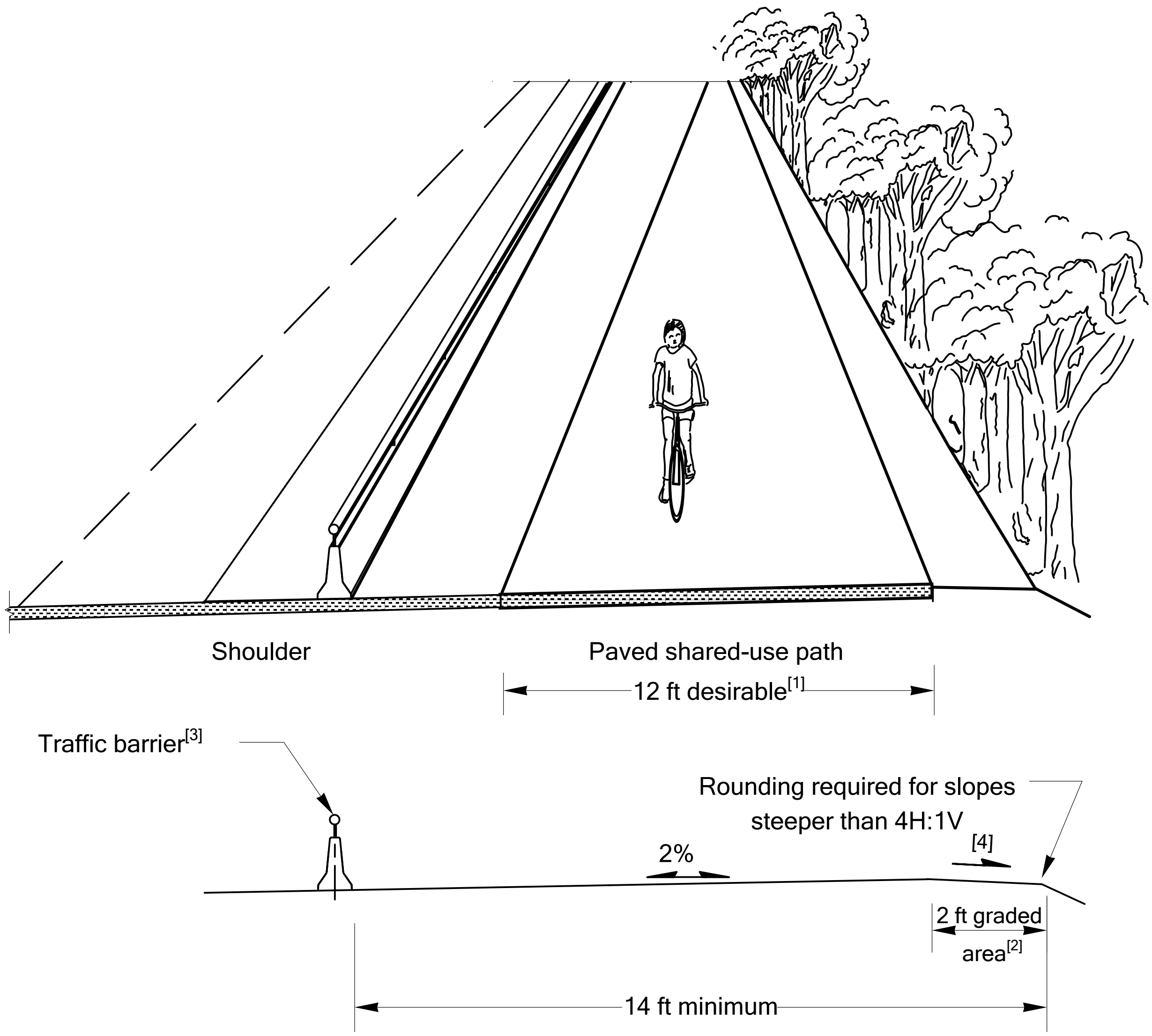
[1] For further discussion on shared-use path widths, see 1515.03(2).

[2] Where the paved width is wider than 10 ft, the graded area may be reduced accordingly. Use a compacted crushed rock material for the graded area; consult with the Region Materials Engineer.

[3] Not steeper than 6H:1V; 2% desirable.

Two-Way Shared-Use Path: Independent Alignment

Exhibit 1515-3



Notes:

[1] For further discussion on shared-use path widths, see 1515.03(2).

[2] Where the paved width is wider than 10 ft, the graded area may be reduced accordingly. Use a compacted crushed rock material for the graded area; consult with the Region Materials Engineer.

[3] For selecting barriers between shared-use path and shoulder, and for determining the need for fencing on limited access roadways, see 1515.03(13).

[4] Not steeper than 6H:1V; 2% desirable.

General:

When path is adjacent to roadway, its running slope can match the grade of the roadway but not exceed it.

Two-Way Shared-Use Path: Adjacent to Roadway

Exhibit 1515-4

(4) Running Slopes, Landings, and Rest Areas

(a) Running Slopes

It is desirable to keep running slopes (grades) on shared-use paths 5% or less to accommodate all user types. When the path is adjacent to the roadway, its running slope can match the grade of the roadway but not exceed it.

Requirements for running slopes include:

- Where it is impracticable to achieve 5% or less, with justification, the running slope for a shared-use path may exceed 5%, but be no more than 8.3% (for short sections).
- Provide a smooth vertical transition when the running slope changes.
- When running slope design exceeds 5%, contact the region ADA Coordinator and the Headquarters (HQ) Design Office for further design guidance.

(b) Landings

Shared-use path landings provide users a place to rest on running slopes between 5% and 8.3 % and a level area to turn into an adjacent rest area. Exhibit 1515-1 shows these features.

Requirements for landings include:

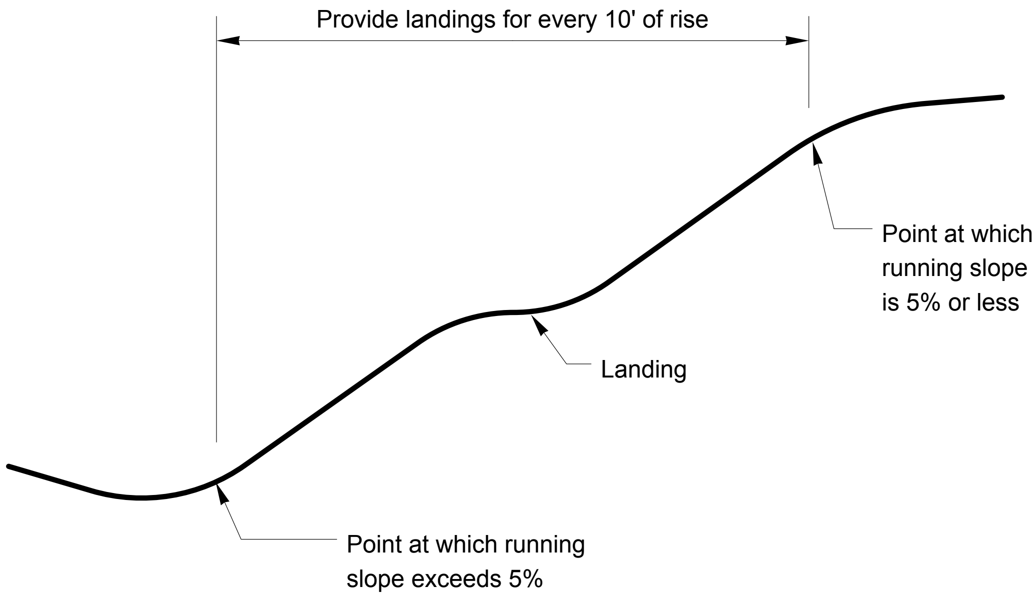
- Provide landings on running slopes exceeding 5% for every 10 feet or less of elevation change, as shown in Exhibit 1515-6. Consult with the ADA Coordinator early to obtain endorsement of landing locations. Obtain Assistant State Design Engineer concurrence on landing designs and spacing.
- The maximum running and cross slopes of a landing are 2%.
- Landings are to be in line with the shared-use path and at least as wide as the path.
- Landings are to be at least 5 feet long.
- Provide smooth vertical transitions into and out of the landing. It is undesirable to have abrupt grade changes.

(c) Rest Areas

Although not required, rest areas may be provided adjacent to the path, as shown in Exhibit 1515-6. These provide the additional benefit of a resting area outside the path travelled way.

Requirements for rest areas include:

- The maximum slope is 2%.
- The minimum size is to be 5 feet by 5 feet.
- If features such as benches are provided, they must meet ADA requirements; consult with the region ADA Coordinator for guidance.



Notes:

- Maximum running slopes up to 8.3% are allowed.
- Landings are required on running slopes that exceed 5%.
- This example shows one landing and is not to scale.
- Exhibit 1515-6 illustrates a landing and a rest area.

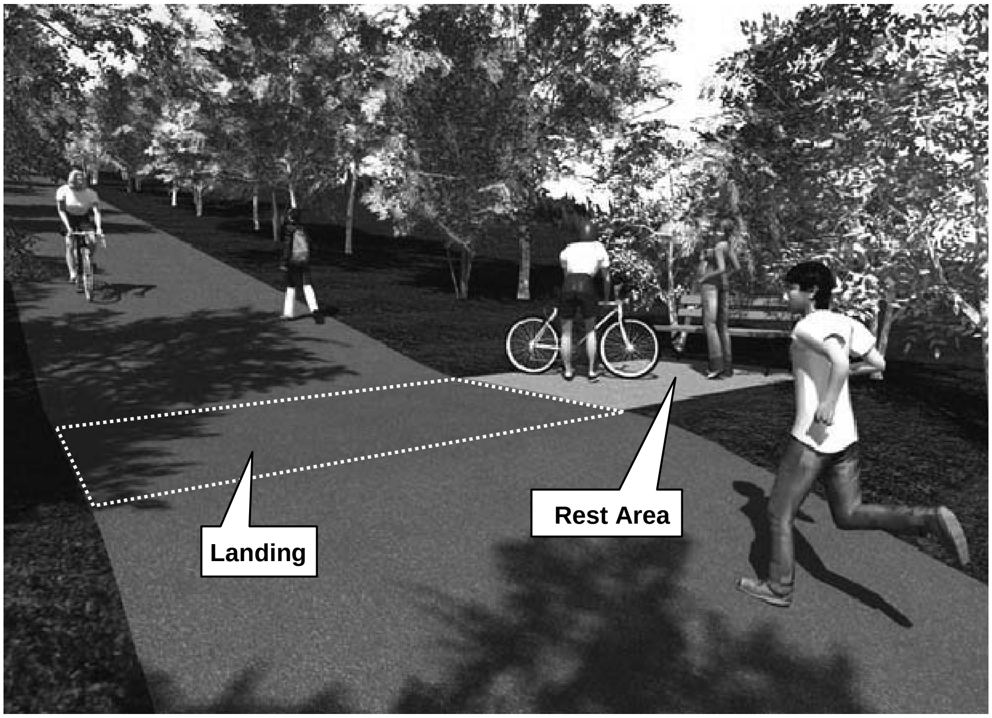
Shared-Use Path Landings Profile
Exhibit 1515-5

(5) Vertical Clearance

Provide a minimum vertical clearance of 10 feet from pavement to overhead obstructions.

(6) Horizontal Alignment

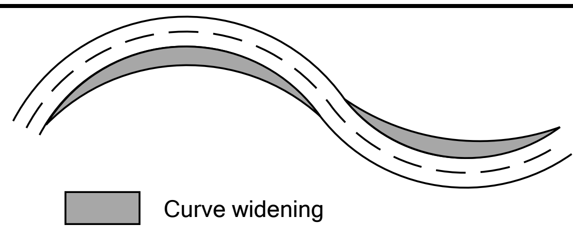
When radii less than given in Exhibit 1515-2 are needed, increase pavement width by up to 4 feet on the inside of a curve to compensate for bicyclist lean (see Exhibit 1515-7).



Notes:

- Design in-line landings at least 5 feet long and as wide as the shared-use path.
- Design in-line landings with a maximum cross slope and running slope of 2%.
- Design vertical curves to transition from the steep grade to the landing. It is undesirable to have abrupt grade changes.
- A rest area is shown adjacent to the path landing.

Shared-Use Path Landing and Rest Area
Exhibit 1515-6



Radius (ft)	Additional Pavement Width (ft)
0 – 25	4
25 – 50	3
50 – 75	2
75 – 100	1
100 +	0

Shared-Use Path Curve Widening
Exhibit 1515-7

(7) Horizontal Clearance to Obstructions

The minimum horizontal clearance from the edge of pavement to an obstruction (such as bridge piers or guardrail) is 2 feet. Where this clearance cannot be obtained, document justification and install signs and pavement markings to warn users of the condition. (For pavement marking details, see the MUTCD and the *Standard Plans*.)

Where a shared-use path is adjacent to canals, ditches, fill slopes steeper than 3H:1V, or where obstacles that present a risk exist at the bottom of an embankment, consider a minimum 5-foot separation from the edge of the pavement.

A physical barrier, such as dense shrubbery, railing, or chain link fencing, is needed at the top of a high embankment. When barrier or railing is installed, see 1515.03(13).

(8) Stopping Sight Distance

Exhibit 1515-12 gives the minimum stopping sight distances for various design speeds and grades.

(9) Sight Distance on Crest Vertical Curves

Exhibit 1515-13 gives the minimum lengths of crest vertical curves for varying design speeds. The values are based on a 4.5-foot eye height for the bicyclist and a 0-foot height for the object (roadway surface).

(10) Sight Distance on Horizontal Curves

Exhibit 1515-14 gives the minimum clearances to line-of-sight obstructions for sight distance on horizontal curves. Provide lateral clearance based on the sum of stopping sight distances from Exhibit 1515-14 for bicyclists traveling in both directions and the proposed horizontal curve radius. Where this minimum clearance cannot be obtained, provide curve warning signs and use centerline pavement markings in accordance with the MUTCD.

(11) Intersections With Roadways

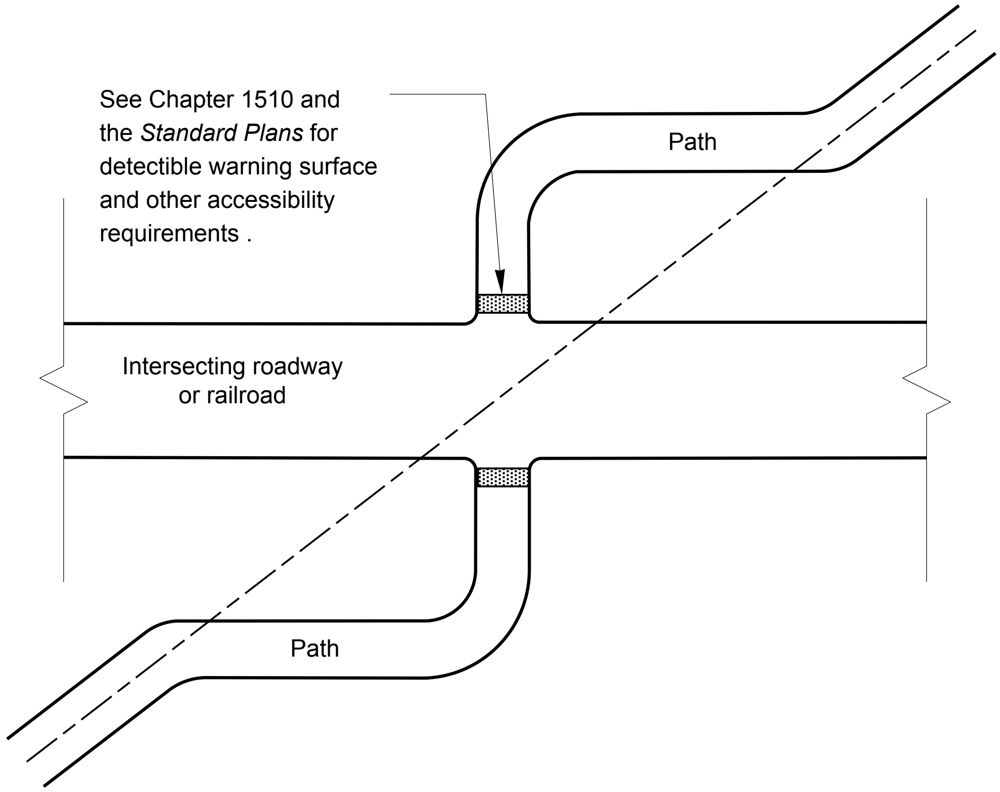
Clearly define who has the right of way and provide sight distance for all users at shared-use path and roadway intersections.

The common types of shared-use path/roadway at-grade intersection crossings are midblock and adjacent.

For roadway intersections with roundabouts, see Chapter 1320.

Midblock crossings are located between roadway intersections. Installation of a midblock crossing on a state highway is a design deviation that requires ASDE approval and documentation. When possible, locate the path crossings far enough away from intersections to minimize conflicts between the path users and motor vehicle traffic. A 90° crossing is desirable; however, a 75° angle is acceptable. A 45° angle is the minimum acceptable to minimize the right of way needed. A diagonal midblock crossing can be altered as shown in Exhibit 1515-8.

There are other considerations when designing midblock crossings. They include traffic right of way assignments; traffic control devices; sight distances for both bicyclists and motor vehicle operators; refuge island use; access control; and pavement markings.



Note:
For path and highway signing and markings, see the MUTCD and the *Standard Plans*.

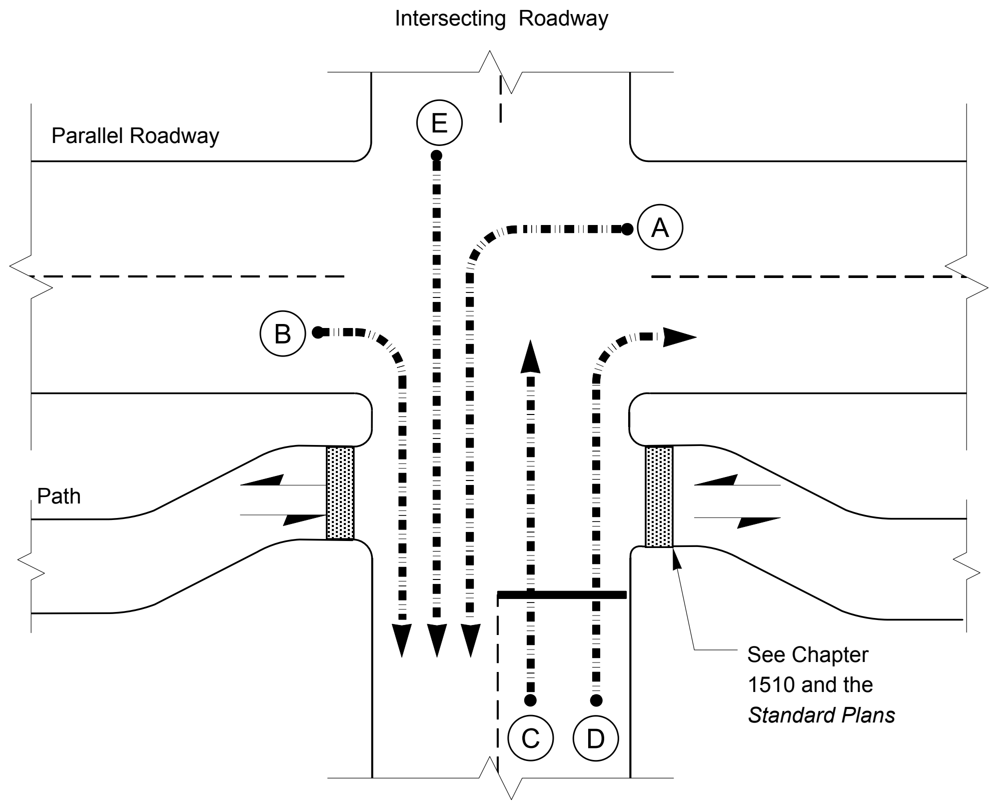
Typical Redesign of a Diagonal Midblock Crossing
Exhibit 1515-8

Adjacent path crossings are located at or near public intersection crosswalks and are normally placed with them. These crossings are usually placed with pedestrian crossings, where motorists can be expected to stop. If alternate intersection locations for a shared-use path are available, select the one with the greatest sight distance.

Adjacent path crossings occur where a path crosses an existing intersection of two roadways, a T intersection (including driveways), or a four-way intersection, as shown in Exhibit 1515-9. It is desirable to integrate this type of crossing close to an intersection so that motorists and path users recognize one another as intersecting traffic. The path user faces potential conflicts with motor vehicles turning left (A) and right (B) from the parallel roadway and on the crossed roadway (C, D, and E).

Consider crossing improvements on a case-by-case basis. Suggested improvements include: move the crossing; evaluate existing or proposed intersection control type; change signalization timing; or provide a refuge island and make a two-step crossing for path users.

Important elements that greatly affect the design of these crossings are traffic right of way assignments, traffic control devices, and the separation distance between path and roadway.



Note:
For signing, see the MUTCD and the *Standard Plans*.

Adjacent Shared-Use Path Intersection
Exhibit 1515-9

(a) Additional Roadway/Path Intersection Design Considerations

Additional roadway/path intersection design considerations include the following:

1. Evaluate Intersection Control

Determine the need for traffic control devices at path/roadway intersections by using MUTCD warrants and engineering judgment. Bicycles are considered vehicles in Washington State, and bicycle path traffic can be classified as vehicular traffic for MUTCD warrants. Provide traffic signal timing set for pedestrians.

2. Signal Actuation Mechanisms

Place the manually operated accessible pedestrian signal button in a location that complies with ADA requirements. For additional information, see Chapters 1330 and 1510. A detector loop in the path pavement may be provided in addition to the manually operated accessible pedestrian signal button.

3. **Signing**

Provide sign type, size, and location in accordance with the MUTCD. Place path STOP signs as close to the intended stopping point as feasible. Do not place the shared-use path signs where they may confuse motorists or place roadway signs where they may confuse shared-use path users. For additional information on signing, see the MUTCD and Chapter 1020.

4. **Approach Treatments**

Design shared-use path and roadway intersections with level grades, and provide sight distances. Provide advance warning signs and pavement markings (see the MUTCD) that alert and direct path users that there is a crossing. Do not use speed bumps or other similar surface obstructions intended to cause bicyclists to slow down. Consider some slowing features such as horizontal curves. Avoid locating a crossing where there is a steep downgrade where bike speeds could be high.

5. **Sight Distance**

Sight distance is a principal element of roadway and path intersection design. At a minimum, provide stopping sight distance for both the roadway and the path at the crossing. Decision sight distance is desirable for the roadway traffic. (See Chapter 1260 for stopping sight distance for the roadway and 1515.03(8), (9), and (10) for shared-use path stopping sight distance.)

6. **Curb Ramp Widths**

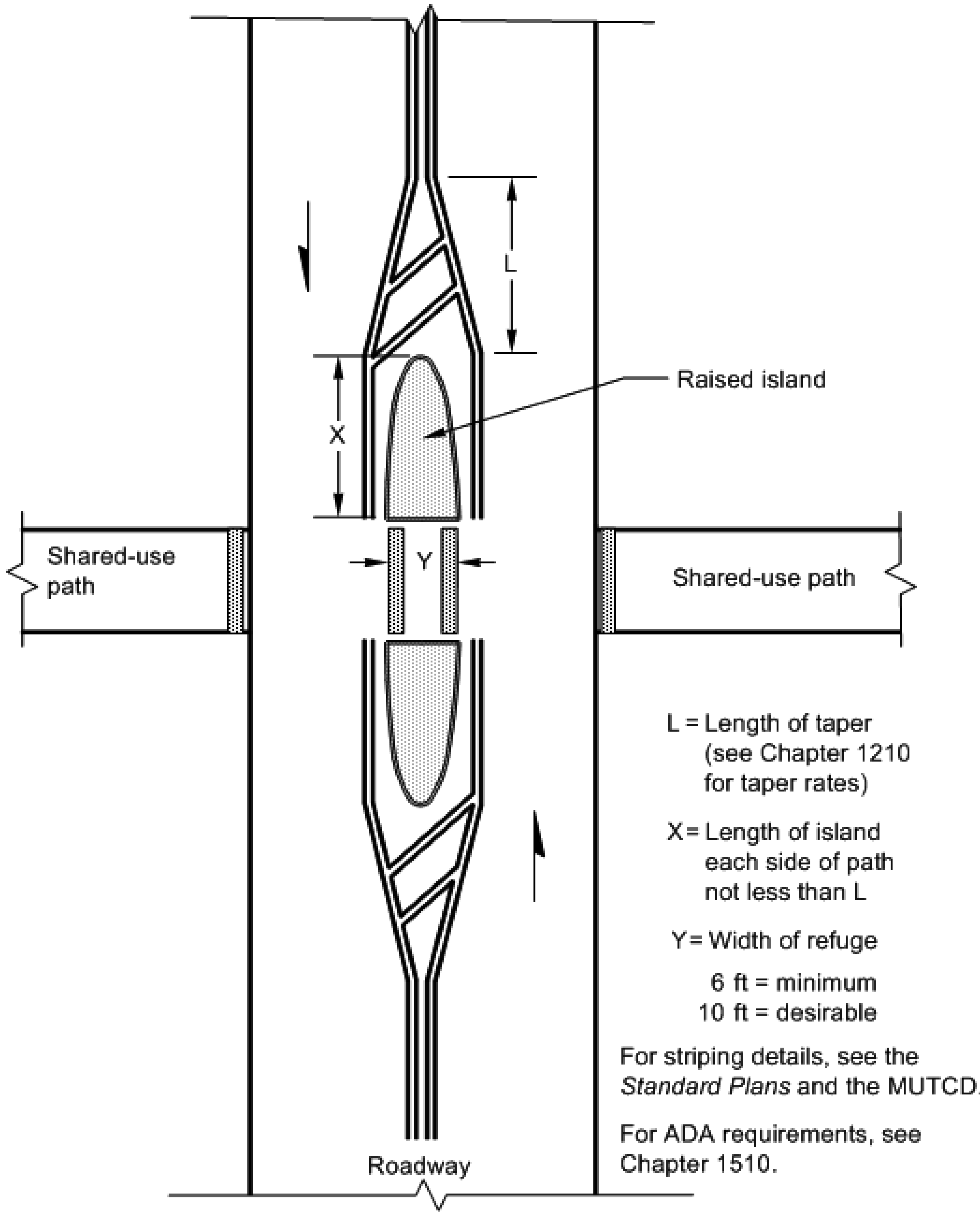
Design curb ramps with a width equal to the shared-use path width. Curb ramps and barrier-free passageways are to provide a smooth transition between the shared-use path and the roadway or sidewalk (for pedestrians). Curb ramps at path/roadway intersections must meet the requirements for sidewalk curb ramp at a crosswalk. For design requirements, see Chapter 1510, and for curb ramp treatments at roundabouts, see Chapter 1320.

7. **Refuge Islands**

Consider refuge islands where a shared-use path crosses a roadway when one or more of the following applies: high motor vehicle traffic volume and speeds; wide roadways; or use by the elderly, children, the disabled, or other slow-moving users. (See Exhibit 1515-10 for details.) The refuge area may be designed with the storage aligned perpendicularly across the island (as shown in Exhibit 1515-10) or via a diagonal. The diagonal storage area has the added benefit of directing attention toward oncoming traffic; therefore, it should be angled toward the direction from which traffic is approaching.

(12) At-Grade Railroad Crossings

Wherever possible, design the crossing at right angles to the rails. For signing and pavement marking for a shared-use path crossing a railroad track, see the MUTCD and the *Standard Plans*. Also, see 1510.05(13) for design of at-grade pedestrian railroad crossings.



Refuge Area
Exhibit 1515-10

(13) Separation, Barrier, and Fencing

Where possible, provide a wide separation between a shared-use path and the roadway's traveled way where the path is located near a roadway.

If the shared-use path is inside the Design Clear Zone, provide a concrete traffic barrier (see Exhibit 1515-11). A concrete barrier presents a lower risk to bicyclists than beam guardrail and is preferred. However, if the edge of the path is farther than 10 feet from the barrier, a beam guardrail is also acceptable. For Design Clear Zone guidance, see Chapter 1600, and for barrier location and deflection, see Chapter 1610.

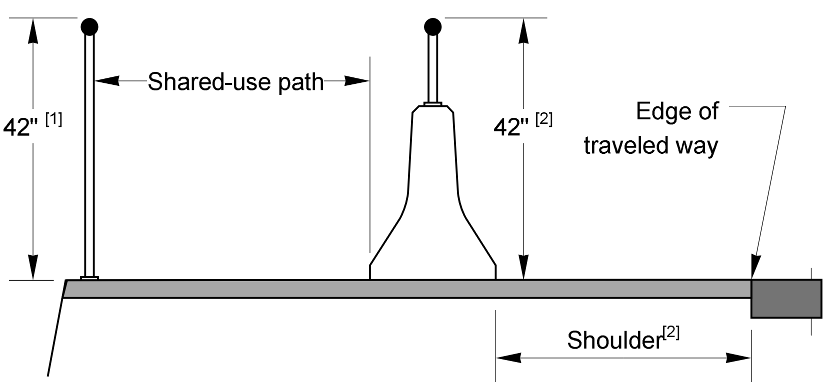
All barrier and railing adjacent to a shared-use path must meet the criteria for pedestrians (see Chapter 1510). When the edge of the path is within 5 feet of a barrier or railing, provide a taller barrier—a minimum of 42 inches—to reduce the potential for bicyclists to fall over the barrier. For barrier between the path and a roadway, if the roadway shoulder is 6 feet or wider, additional barrier height is not needed.

Where the path is to be located next to a limited access facility, provide an access barrier. Where space permits, provide fencing as described in Chapter 560, in conjunction with a normal height barrier. Otherwise, provide a taller barrier—54-inch minimum height.

Fencing between a shared-use path and adjacent property may also be installed to restrict access to the private property. Discuss the need for fencing and the appropriate height with the property owners during project design.

On structures, the bridge railing type and height are part of the structure design. Contact the HQ Bridge and Structures Office for additional information. (See Chapter 720 for further considerations.)

Evaluate the impacts of barriers and fencing on sight distances.



Notes:

[1] Height does not apply to bridge rail. On structures, the bridge railing type and height are part of the structure design. (Contact the HQ Bridge and Structures Office for additional information.)

[2] When shoulder width is 6 ft or more, additional rail height for bicycles is not needed. (See 1515.03(13) for additional information.)

Barrier Adjacent to Shared-Use Path
Exhibit 1515-11

(14) Pavement Structural Section

Design the pavement structural section of a shared-use path in the same manner as a highway, considering the quality of the subgrade and the anticipated loads on the path. (Design loads are normally from maintenance and emergency vehicles.) Provide a firm, smooth, slip-resistant pavement surface.

Unless otherwise justified, use hot mix asphalt (HMA) pavement in the construction of a shared-use path. For most common shared-use paths, the desirable minimum HMA thickness is 0.20 feet placed over 0.25 feet of crushed surfacing base course. Design the final pavement structural section as recommended by the Region Materials Engineer.

Use a crushed rock or other suitable material for shoulder graded areas. Consult with the Region Materials Engineer.

(15) Pedestrian Overcrossing and Undercrossing Structures

Structures intended to carry a shared-use path only are designed using pedestrian loads and emergency and maintenance vehicle loading for live loads.

Provide the same minimum clear width as the approach paved shared-use path plus the graded clear areas (see Exhibits 1515-3 and 1515-4).

Carrying full widths across structures has two advantages:

- The clear width provides a minimum horizontal shy distance from the railing or barrier.
- It provides needed maneuvering room to avoid pedestrians and other bicyclists.

For undercrossings and tunnels, provide a minimum vertical clearance of 10 feet from the pavement to the structure. This allows access by emergency, patrol, and maintenance vehicles on the shared-use path.

Consult the region Maintenance Office and the HQ Bridge Preservation Office to verify that the planned path width meets their needs. If not, widen to their specifications.

Provide a smooth, nonskid surface to traverse the shared-use path across bridges.

Use expansion joints for decks that accommodate bikes and wheelchairs. Expansion joints should be perpendicular to the path and have a maximum gap of ½ inch or be covered with a skid-resistant plate.

On structures, the bridge railing type and height are part of the structure design. Contact the HQ Bridge and Structures Office for further information. (See Chapter 720 for additional considerations.)

(16) Drainage

Sloping the pavement surface to one side usually simplifies drainage design and surface construction, and it is desirable. (For cross slope, see 1515.03(3).) Generally, surface drainage from the path is dissipated as it flows down the side slope. However, a shared-use path constructed on the side of a hill might need a drainage ditch on the uphill side to intercept the hillside drainage. Install catch basins with drains as needed to carry intercepted water under the path. (See Chapter 800 for other drainage criteria.)

Locate drainage inlet grates and manhole covers off the pavement of shared-use paths.

(17) Bollards

Install bollards at entrances to shared-use paths to discourage motor vehicles from entering. Do not use bollards to divert or slow path traffic. When locating such installations, stripe an envelope around the bollards and paint and reflectorize them to be visible to path users both day and night. Bollards located in or adjacent to shared-use paths represent an object that needs to be avoided by bicyclists, pedestrians, and wheelchair users. To increase the potential for appropriate maneuvering to occur, provide designs where the post is clearly visible and recognizable.

When designing bollards, the following information applies:

- The desirable design is to provide a single bollard, installed in the middle of the path to reduce confusion.
- When multiple bollard posts are used in wide path sections, use a minimum 5-foot spacing between bollard posts to permit passage of bicycle-towed trailers, wheelchairs, and adult tricycles, with room for bicycle passage without dismounting.
- Provide 4 feet minimum (5 feet desirable) clear width between the face of bollard and edge of path.
- At a minimum, provide stopping sight distance to bollards. An ideal location for bollard placement is in a relatively straight area of the path where the post placement has the stopping sight distance given in Exhibit 1520-13. Do not place bollards in difficult-to-see locations (for example, immediately upon entering a tunnel).
- For cases where multiple posts are used longitudinally along the path, locate them at least 20 feet apart, with the first post in line from each direction having stopping sight distance.
- Use a contrasting striping pattern on the post.
- Use reflective materials on the post, such as a band at the top and at the base.
- Design all bollards along a corridor to be uniform in appearance. Frequent cyclists can become familiar with the posts and recognize them easily.
- Provide pavement markings in accordance with the *Standard Plans* at all bollards on paved paths.
- Use removable bollards (Bollard Type 1) to permit access by emergency and service vehicles. Use bollard sleeves that are flush with the pavement surface.
- Nonremovable bollards (Bollard Type 2) may be used where access is not needed.

Refer to the *Standard Plans* for bollard designs and the MUTCD for pavement markings at bollards.

When bollards need to be placed near the roadway, see Chapter 1600 for clear zone requirements.

(18) Signing and Pavement Markings

Generally, WSDOT does not provide centerline striping on shared-use paths. For guidance and directions regarding signing and pavement markings on shared-use paths, see the MUTCD.

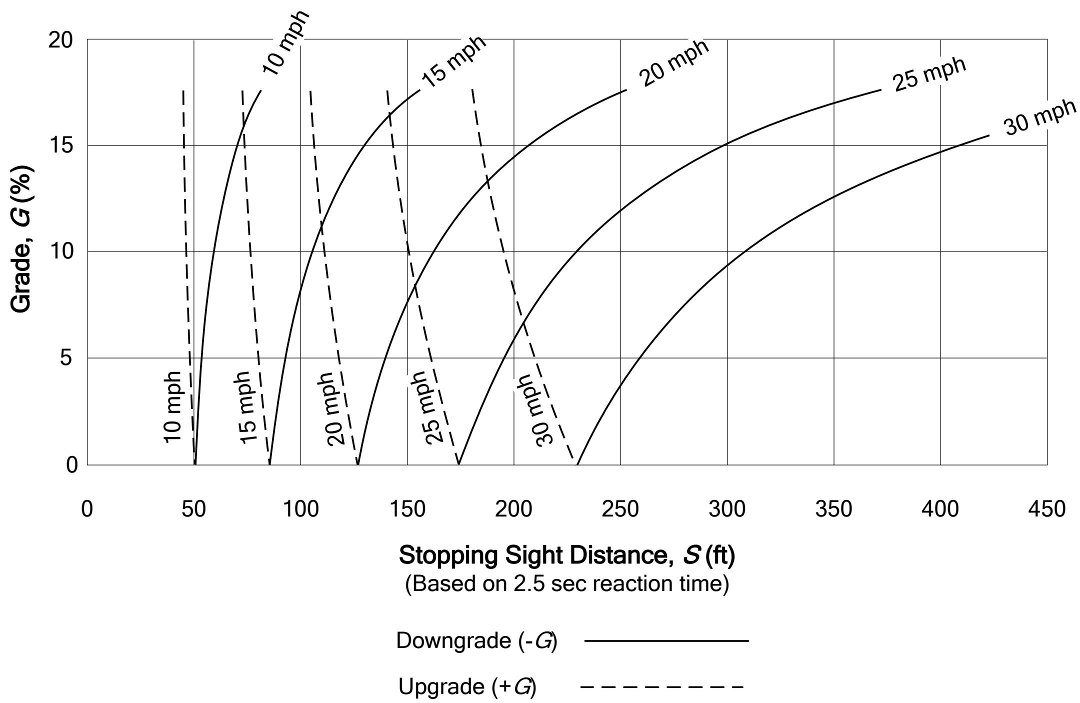
For pavement marking around bollards, see the *Standard Plans*.

(19) Lighting

The level of illumination on a shared-use path is dependent upon the amount of nighttime use expected and the nature of the area surrounding the facility. Provide illumination in accordance with Chapter 1040.

1515.04 Documentation

For the list of documents required to be preserved in the Design Documentation Package and the Project File, see the Design Documentation Checklist:
www.wsdot.wa.gov/design/projectdev/



$$S = \frac{V^2}{0.30(f \pm G)} + 3.67V$$

Where:

S = Stopping sight distance (ft)

V = Speed (mph)

F = Coefficient of friction (use 25)

G = Grade (%)

Stopping Sight Distance
Exhibit 1515-12

A (%)	Stopping Sight Distance, *S* (ft)													
	40	**60**	**80**	**100**	**120**	**140**	**160**	**180**	**200**	**220**	**240**	**260**	**280**	**300**
2	3	3	3	3	3	3	3	3	3	3	30	70	110	150
3	3	3	3	3	3	3	20	60	100	140	180	220	260	300
4	3	3	3	3	15	55	95	135	175	215	256	300	348	400
5	3	3	3	20	60	100	140	180	222	269	320	376	436	500
6	3	3	10	50	90	130	171	216	267	323	384	451	523	600
7	3	3	31	71	111	152	199	252	311	376	448	526	610	700
8	3	8	48	88	128	174	228	288	356	430	512	601	697	800
9	3	20	60	100	144	196	256	324	400	484	576	676	784	900
10	3	30	70	111	160	218	284	360	444	538	640	751	871	1,000
11	3	38	78	122	176	240	313	396	489	592	704	826	958	1,100
12	5	45	85	133	192	261	341	432	533	645	768	901	1,045	1,200
13	11	51	92	144	208	283	370	468	578	699	832	976	1,132	1,300
14	16	56	100	156	224	305	398	504	622	753	896	1,052	1,220	1,400
15	20	60	107	167	240	327	427	540	667	807	960	1,127	1,307	1,500
16	24	64	114	178	256	348	455	576	711	860	1,024	1,202	1,394	1,600
17	27	68	121	189	272	370	484	612	756	914	1,088	1,277	1,481	1,700
18	30	72	128	200	288	392	512	648	800	968	1,152	1,352	1,568	1,800
19	33	76	135	211	304	414	540	684	844	1,022	1,216	1,427	1,655	1,900
20	35	80	142	222	320	436	569	720	889	1,076	1,280	1,502	1,742	2,000
21	37	84	149	233	336	457	597	756	933	1,129	1,344	1,577	1,829	2,100
22	39	88	156	244	352	479	626	792	978	1,183	1,408	1,652	1,916	2,200
23	41	92	164	256	368	501	654	828	1,022	1,237	1,472	1,728	2,004	2,300
24	43	96	171	267	384	523	683	864	1,067	1,291	1,536	1,803	2,091	2,400
25	44	100	178	278	400	544	711	900	1,111	1,344	1,600	1,878	2,178	2,500

Minimum Length of Vertical Curve, *L* (ft)

$$L = \frac{AS^2}{900} \quad \text{when } S < L$$

$$L = 2S - \frac{900}{A} \quad \text{when } S > L$$

Shaded area represents $S \leq L$.

Where:
S = Stopping sight distance (ft)
A = Algebraic difference in grade (%)
L = Minimum vertical curve length (ft)
Based on an eye height of 4.5 ft and an object height of 0 ft.

Sight Distances for Crest Vertical Curves
Exhibit 1515-13

Height of eye: 4.50 ft

Height of object: 0.0 ft

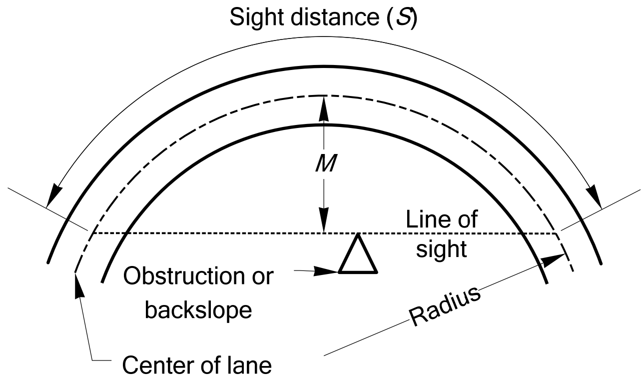
Line of sight at the M distance is normally 2.25 ft above centerline of inside lane at point of obstruction, provided no vertical curve is present in horizontal curve.

$$M = R\left(1 - \text{COS}\,\frac{S\,28.65}{R}\right)$$

$$S = \frac{R}{28.65}\left[\text{COS}^{-1}\left(\frac{R-M}{R}\right)\right]$$

$S \leq$ Length of curve

Angle is expressed in degrees.



Where:

S = Sight distance (ft)

R = Centerline radius of inside lane (ft)

M= Distance from inside lane centerline (ft)

R **(ft)**	**Stopping Sight Distance, S (ft)[1]**													
	40	**60**	**80**	**100**	**120**	**140**	**160**	**180**	**200**	**220**	**240**	**260**	**280**	**300**
25	7.6	15.9												
50	3.9	8.7	15.2	23.0	31.9	41.5								
75	2.7	5.9	10.4	16.1	22.7	30.4	38.8	47.8	57.4	67.2				
95	2.1	4.7	8.3	12.9	18.3	24.6	31.7	39.5	47.9	56.9	66.2	75.9	85.8	
125	1.6	3.6	6.3	9.9	14.1	19.1	24.7	31.0	37.9	45.4	53.3	61.7	70.5	79.7
150	1.3	3.0	5.3	8.3	11.8	16.0	20.8	26.2	32.1	38.6	45.5	52.9	60.7	69.0
175	1.1	2.6	4.6	7.1	10.2	13.8	18.0	22.6	27.8	33.4	39.6	46.1	53.1	60.4
200	1.0	2.2	4.0	6.2	8.9	12.1	15.8	19.9	24.5	29.5	34.9	40.8	47.0	53.7
225	0.9	2.0	3.5	5.5	8.0	10.8	14.1	17.8	21.9	26.4	31.2	36.5	42.2	48.2
250	0.8	1.8	3.2	5.0	7.2	9.7	12.7	16.0	19.7	23.8	28.3	33.0	38.2	43.7
275	0.7	1.6	2.9	4.5	6.5	8.9	11.6	14.6	18.0	21.7	25.8	30.2	34.9	39.9
300	0.7	1.5	2.7	4.2	6.0	8.1	10.6	13.4	16.5	19.9	23.7	27.7	32.1	36.7
350	0.6	1.3	2.3	3.6	5.1	7.0	9.1	11.5	14.2	17.1	20.4	23.9	27.6	31.7
400	0.5	1.1	2.0	3.1	4.5	6.1	8.0	10.1	12.4	15.0	17.9	20.9	24.3	27.8
500	0.4	0.9	1.6	2.5	3.6	4.9	6.4	8.1	10.0	12.1	14.3	16.8	19.5	22.3
600	0.3	0.7	1.3	2.1	3.0	4.1	5.3	6.7	8.3	10.1	12.0	14.0	16.3	18.7
700	0.3	0.6	1.1	1.8	2.6	3.5	4.6	5.8	7.1	8.6	10.3	12.0	14.0	16.0
800	0.2	0.6	1.0	1.6	2.2	3.1	4.0	5.1	6.2	7.6	9.0	10.5	12.2	14.0
900	0.2	0.5	0.9	1.4	2.0	2.7	3.6	4.5	5.5	6.7	8.0	9.4	10.9	12.5
1,000	0.2	0.4	0.8	1.2	1.8	2.4	3.2	4.0	5.0	6.0	7.2	8.4	9.8	11.2

Minimum Lateral Clearance, M (ft)

Note:

[1] S is the sum of the distances (from Exhibit 1515-13) for bicyclists traveling in both directions.

Lateral Clearance on Horizontal Curves

Exhibit 1515-14

Chapter 1520 Roadway Bicycle Facilities

1520.01 General

The Washington State Department of Transportation (WSDOT) encourages bicycle use on its facilities. Bicycle facilities (bike lanes and shared roadways), or improvements for bicycle transportation, are included in the project development and highway programming processes.

This chapter is a guide for designing bicycle facilities within the roadway when the design matrices (see Chapter 1100) indicate full design level for bicycle and pedestrian design elements. (For shared-use paths, see Chapter 1515.) These guidelines apply to normal situations encountered during project development. Unique design problems are resolved on a project-by-project basis using guidance from the region's Bicycle Coordinator or bicycle and pedestrian expert.

1520.02 References

(1) Federal/State Laws and Codes

Americans with Disabilities Act of 1990 (ADA)

23 Code of Federal Regulations (CFR) Part 652, Pedestrian and Bicycle Accommodations and Projects

Revised Code of Washington (RCW), Chapter 35.75, Streets – Bicycles – Paths
http://apps.leg.wa.gov/rcw/default.aspx?cite=35.75

RCW 46.04, Definitions
http://apps.leg.wa.gov/rcw/default.aspx?cite=46.04

RCW 46.61, Rules of the road
http://apps.leg.wa.gov/rcw/default.aspx?cite=46.61

RCW 46.61.710, Mopeds, electric-assisted bicycles – General requirements and operation
http://apps.leg.wa.gov/rcw/default.aspx?cite=46.61.710

RCW 47.26.300, Bicycle routes – Legislative declaration
http://apps.leg.wa.gov/rcw/default.aspx?cite=47.26.300

(2) Design Guidance

Manual on Uniform Traffic Control Devices for Streets and Highways, USDOT, FHWA; as adopted and modified by Chapter 468-95 WAC "Manual on uniform traffic control devices for streets and highways" (MUTCD)
www.wsdot.wa.gov/publications/manuals/mutcd.htm

Selecting Roadway Design Treatments to Accommodate Bicycles, USDOT, Federal Highway Administration (FHWA), 1994

Standard Plans for Road, Bridge, and Municipal Construction (Standard Plans), M 21-01, WSDOT
www.wsdot.wa.gov/publications/manuals/m21-01.htm

Understanding Flexibility in Transportation Design – Washington, WSDOT, 2005
www.wsdot.wa.gov/research/reports/600/638.1.htm

(3) Supporting Information

A Policy on Geometric Design of Highways and Streets (Green Book), AASHTO, 2004

1520.03 Definitions

bicycle Any device propelled solely by human power upon which a person or persons may ride, having two tandem wheels, either of which is 16 inches or more in diameter, or three wheels, any one of which is more than 20 inches in diameter.

bicycle route A system of facilities that are used or have a high potential for use by bicyclists or that are designated as such by the jurisdiction having the authority. A series of bicycle facilities may be combined to establish a continuous route and may consist of any or all types of bicycle facilities.

bike lane A portion of a highway or street identified by signs and pavement markings as reserved for bicycle use.

shared roadway A roadway that is open to both bicycle and motor vehicle travel. This may be a new or existing roadway/highway, a street with wide curb lanes, or a road with paved shoulders.

signed shared roadway A shared roadway that has been designated by signing as a route for bicycle use.

shared-use path See Chapter 1515.

wye (Y) connection An intersecting one-way roadway, intersecting at an angle less than 60°, in the general form of a "Y."

1520.04 Facility Selection

(1) Facility Location

Provide bicycle facilities on routes that have been identified as local, state, or regional significant bike routes. Fill gaps in the existing network of bicycle facilities when the opportunity is available. For other roadways, provide full design level shoulders for bicycle needs unless:

- Bicyclists are prohibited by law from using the facility.
- The cost is excessively disproportionate to the need or probable use.
- Other factors indicate there is no need.

Refer to *Understanding Flexibility in Transportation Design – Washington* for further information.

(2) Selection of the Type of Facility

Selection of the facility type includes consideration of community needs and safe, efficient bicycle travel. Exhibit 1520-1 provides a generalized method of assessing the type of bicycle facility needed.

Roadway Classification, Land Use, Speed, and ADT	Facility Recommendation
Rural and suburban highways and streets (less than four dwelling units per acre), speeds above 25 mph, and ADT above 2,000.	Full design level shoulder (see Chapter 1140) on both sides (4 ft minimum width), or shared-use path (see Chapter 1515).
Major arterial in residential area, school zones, or streets in commercial or industrial areas.	Bike lanes on both sides (see 1520.07), or shared-use path (see Chapter 1515).
Local street in residential area where speed is 25 mph or below, or ADT is 2,000 or less. Rural highways and streets where passing sight distance is available and speed is 25 mph or below, or ADT is 2,000 or less. Collector or minor arterial where speed is 25 mph or below, or ADT is 2,000 or less.	Shared roadway.

Bike Facility Selection
Exhibit 1520-1

An important consideration is route continuity. Change facility types at logical locations. For additional information, see *Understanding Flexibility in Transportation Design – Washington*.

1520.05 Project Requirements

For urban bicycle mobility Improvement projects (see Bike/Ped connectivity projects in the matrices, Chapter 1100), apply the guidance in this chapter to the bicycle facility.

For highway design elements affected by the project, apply the appropriate design level from the matrices (see Chapter 1100) and as found in the applicable chapters.

For highway design elements not affected by the project, no action is required.

1520.06 Shared-Use Path Design

Shared-use paths are facilities physically separated from motorized vehicular traffic within the highway right of way or on an exclusive right of way with minimal crossflow by motor vehicles. Primarily used by pedestrians and bicyclists, shared-use paths are also used by joggers, skaters, wheelchair users (both nonmotorized and motorized), equestrians, and other nonmotorized users. Chapter 1515 provides design guidance for shared-use paths.

1520.07 Shared Roadway Bicycle Facility Design

Generally, lower-speed/lower-volume streets can provide for bicycle travel without additional signing and pavement markings for bicycles (see Exhibit 1520-2).

The region Traffic Engineer is responsible for determining which sections of state highways are inappropriate for bicycle traffic. The State Traffic Engineer, after consultation with the Bicycle Advisory Committee, prohibits bicycling on sections of state highways through the traffic regulation process. Contact the region Traffic Office for further information.

Shared Roadway
Exhibit 1520-2

Bicyclists traveling between cities or on recreational trips may use many rural highways. Providing and maintaining paved shoulders, with or without an edge stripe, can significantly improve convenience for bicyclists and motorists along such routes.

A shared roadway bike route with improvements for bicycles can offer a greater degree of service to bicyclists than other roadways. Improvements on shared roadways to facilitate better bicycle travel include widening the shoulders to full design level width (a minimum of 4 feet), adding pavement markings, improving roadside maintenance (including periodic sweeping), and removing surface obstacles such as drain grates that are not compatible with bicycle tires.

Where public transport and cycling facilities meet, an integrated design that does not inconvenience either mode is desirable. When buses and bicyclists share the same roadway, consider the following:

- Where bus speeds and volumes are high, separate facilities for buses and bicyclists are desirable.
- Where bus speeds and volumes are low, consider a shared-use bus/bicycle lane.

Consider providing bicycle parking facilities near public transportation stops.

1520.08 Signed Shared Bicycle Roadway Design

Signed shared roadways are shared roadways that have been identified as preferred bike routes by the posting of “Bike Route” signs (see Exhibit 1520-3). They provide connections for continuity to other bicycle facilities and designate preferred routes through high-bicycle-demand corridors. Signing shared roadways as bike routes indicates to bicyclists that there are advantages to using these bike routes as compared with alternative routes. (Signing also alerts motorists that bicycles are present.) Provide improvements to make these routes suitable as bike routes, and maintain them in a manner consistent with the needs of bicyclists.

Signed Shared Roadway: Designated Bike Route
Exhibit 1520-3

Use the following criteria to aid in determining whether to designate and sign a bike route:

- The route offers a higher degree of service than alternative streets.
- The route provides for through and direct travel in bicycle corridors.
- The route connects bicycle facilities.
- Traffic control devices have been adjusted to accommodate bicyclists.
- Street parking is prohibited where lane width is critical.
- Surface obstacles to bicyclists have been addressed.
- Maintenance of the route, such as more frequent street sweeping and repair, is at a higher level than comparable streets.

Establish a signed shared roadway bike route by placing MUTCD Bicycle Route signs or markers along the roadways. When the signed shared roadway designates an alternate route, consider destination signing.

1520.09 Bicycle Lane Design

Bicycle lanes are established along streets in corridors where there is current or anticipated bicycle demand and where it is desirable for bikes to be better separated from motor vehicle lanes. Provide bike lanes where it is desirable to delineate available road space for preferential use by bicyclists (see Exhibit 1520-4). Consider bike lanes in and around schools, parks, libraries, and other locations where young cyclists are present.

Bicycle lanes delineate the rights of way assigned to bicyclists and motorists and provide for movements that are more predictable by each. Bike lanes can be provided on existing roadways by reducing the number or width of lanes or prohibiting parking. Design considerations include the impacts to motor vehicle traffic and the loss of parking for nearby land uses.

Bike Lane
Exhibit 1520-4

Where street improvements are not possible, improve the bicyclist's environment by providing shoulder-sweeping programs and special signal facilities.

(1) Widths

The minimum width for a bike lane is 4 feet. Some typical bike lane configurations are illustrated in Exhibit 1520-5 and described below:

- **Design A** depicts bike lanes on an urban-type curbed street where parking stalls (or continuous parking stripes) are marked. Locate bike lanes between the parking area and the traffic lanes. Minimum widths are shown. When the combined width of the bike lane and the parking lane is less than 15 feet, an increased probability of bicycle/car door collisions exists. When wider widths are not available, consider eliminating bike lane marking and signing.

  Do not place bike lanes between the parking area and the curb. Such facilities increase the potential conflicts for bicyclists, such as the opening of car doors and poor visibility at intersections. Also, they restrict bicyclists leaving the bike lane to turn left and they cannot be effectively maintained.

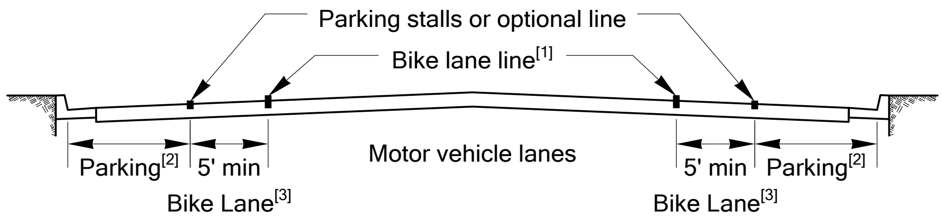
- **Design B** depicts bike lanes on an urban-type curbed street where parking is permitted without pavement markings between the bike lane and the parking lane. Establish bike lanes in conjunction with the parking areas. 12 feet (15 feet desirable) is the minimum total width of the bike lane and parking lane. This design is satisfactory where parking is not extensive and where the turnover of parked cars is infrequent. However, an additional width of 1 to 2 feet is desirable if parking is substantial or the turnover of parked cars is high. Delineated parking lanes are desirable.

- **Design C** depicts bike lanes along the outer portions of a roadway, with and without curb, where parking is prohibited. This configuration eliminates potential conflicts (such as the opening of car doors) with motor vehicle parking. Minimum widths are shown. With curb, guardrail, or barrier, the minimum bike lane width is 5 feet. When a gutter is present, the width may need to be increased to provide a minimum width of 3 feet from the edge of the gutter. Additional width is desirable, particularly where motor vehicle operating speeds exceed 40 mph.

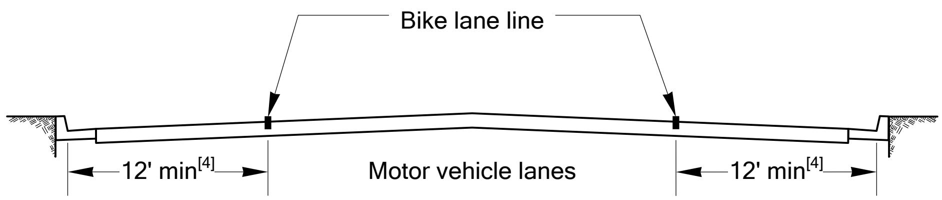
Increase shoulder widths to accommodate bicycle traffic when truck, bus, or recreational vehicle traffic makes up 5% or more of the daily traffic.

Bike lanes are not advisable on long, steep downgrades where bicycle speeds greater than 30 mph can be expected. As grades increase, downhill bicycle speeds increase, which increases the handling difficulty if bicyclists are riding near the edge of the roadway. In such situations, bicycle speeds can approach those of motor vehicles, and experienced bicyclists will generally move into the motor vehicle lanes to increase sight distance and maneuverability. However, less experienced bicyclists may not choose this position. When steep downgrades are unavoidable, provide full design-level shoulder width and signing in accordance with the MUTCD to alert bicyclists of the grade and the need to control their speeds.

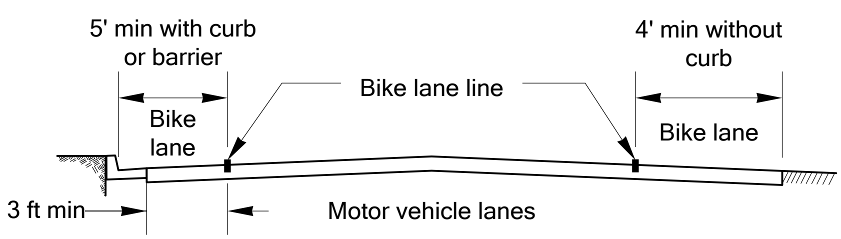
Bike lanes are usually placed on the right side of one-way streets. Consider placing the bike lane on the left side when it produces fewer conflicting movements between bicycles and motor vehicles.



Design A: Marked Parking



Design B: Parking Permitted Without Parking Line or Stall



Design C: Parking Prohibited

Post NO PARKING signs as required.

Notes:

[1] The optional line between the bike lane and the parking lane might be advisable where stalls are not needed (because parking is light), but there is concern that motorists might misconstrue the bike lane to be a traffic lane. (See the MUTCD and the *Standard Plans* for pavement marking.)

[2] For parking lane width, see Chapter 1140. Consider a combined bike lane/parking lane width of 15 ft to reduce the risk of bicycle/car door collisions.

[3] 6 ft is the minimum width when parking lane is less than 10 ft.

[4] 13–14 ft width is desirable where there is substantial parking or the turnover of parked cars is high. Consider a width of 15 ft to reduce the risk of bicycle/car door collisions.

Typical Urban Bike Lane Cross Sections
Exhibit 1520-5

(2) Intersection Design

Design bike lanes at intersections in a manner that minimizes confusion for motorists and bicyclists and permits both users to operate in accordance with the Rules of the Road (RCW 46.61).

Exhibit 1520-6 illustrates a typical intersection of multilane streets with bike lanes on all approaches. Some common movements of motor vehicles and bicycles are shown.

Exhibit 1520-7 illustrates options where bike lanes cross a channelized right-turn-only lane. When approaching such intersections, bicyclists merge with right-turning motorists. Since bicyclists are typically traveling at speeds lower than motorists, they can signal and merge where there is a sufficient gap in right-turning traffic, rather than at any predetermined location. For this reason, it is most effective to end bike lane markings at the approach of the right-turn lane or to extend a single dotted bike lane line across the right-turn lane.

- Parallel lines (delineating a bike lane crossing) to channelize the bike merge are undesirable, as they encourage bicyclists to cross at predetermined locations. In addition, some motorists might assume they have the right of way and neglect to yield to bicyclists continuing straight.
- A dotted line across the right-turn-only lane is undesirable where there are double right-turn-only lanes. For these types of intersections, drop all pavement markings to permit judgment by the bicyclists to prevail.

For signing and pavement marking, see the MUTCD and the *Standard Plans*.

Exhibits 1520-8a and 8b illustrate two design options where bike lanes cross off- and on-ramps or wye connections. Option 1 provides a defined crossing point for bicyclists who want to stay on their original course. This option is desirable where bicyclists do not have a good view of traffic. Use Option 2 where bicyclists normally have a good view of traffic entering or exiting the roadway and will adjust their path to cross-ramp traffic. A bike-crossing sign to warn motorists of the possibility of bicyclists crossing the roadway is desirable.

(3) Traffic Signals

At signalized intersections, consider bicycle traffic needs and intersection geometry when timing the traffic signal cycle and when selecting the method of detecting the presence of the bicyclist. Contact the region's Bicycle Coordinator for assistance in determining the timing criteria. In addition to push button actuators, consider the installation of effective loop detectors or other methods of detecting a bicycle within the bike lane (in advance of the intersection) and turn lanes. Select loop detectors sensitive enough to detect bicycles. Bicyclists generally choose not to go out of their way to use push button actuators. For additional guidance on signal design, see Chapter 1330.

(4) Signing and Pavement Markings

Use the MUTCD and the *Standard Plans* for signing and pavement marking criteria. (See Chapter 1020 for additional information on signing and Chapter 1030 for information on pavement markings.)

(5) Drainage Grates and Manhole Covers

Locate drainage inlet grates and manhole covers to avoid bike lanes. When drainage grates or manhole covers are located in a bike lane, minimize the effect on bicyclists. A minimum of 3 feet of lateral clearance is needed between the edge of a drainage inlet grate and the shoulder stripe. Install and maintain grates and manhole covers level with the surface of the bike lane.

Provide drainage inlet grates on bicycle facilities that have openings narrow enough and short enough that bicycle tires will not drop into the grates. Replace existing grates that are not bicycle-safe with grates designed for bicycles: a WSDOT vaned grate, herringbone grate, or other grate with an opening perpendicular to the direction of travel, 4 inches or less center to center.

(6) At-Grade Railroad Crossings

Whenever a bike lane crosses railroad tracks, continue the crossing at least as wide as the bike lane. Use special construction and materials to keep the flangeway depth and width to a minimum. Wherever possible, design the crossing at right angles to the rails (see Exhibit 1520-9). Where a skew is unavoidable, widen the shoulder, or bike lane, to permit bicyclists to cross at right angles (see Exhibit 1520-9).

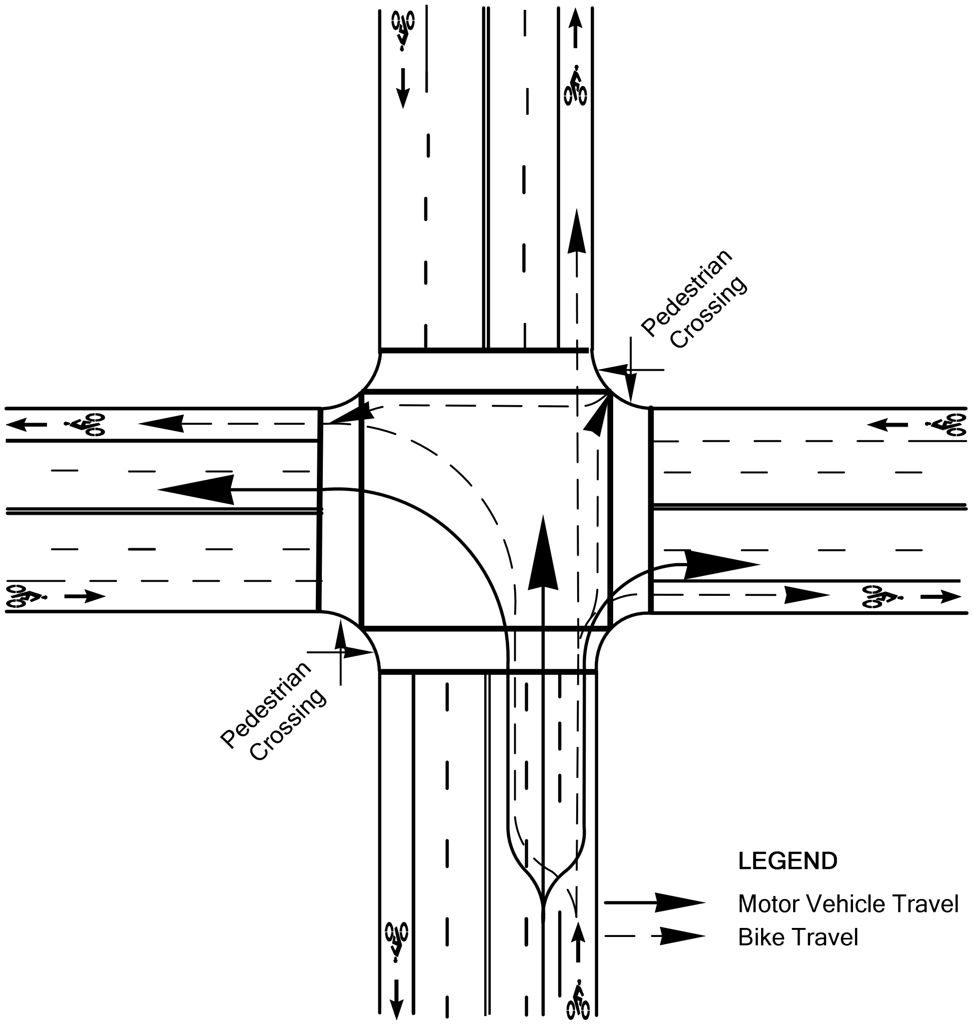
(7) Barrier and Rail

When the edge of the bike lane is within 5 feet of a barrier or railing, provide a barrier height a minimum of 42 inches to reduce the potential for bicyclists to fall over the barrier (see Exhibit 1520-10).

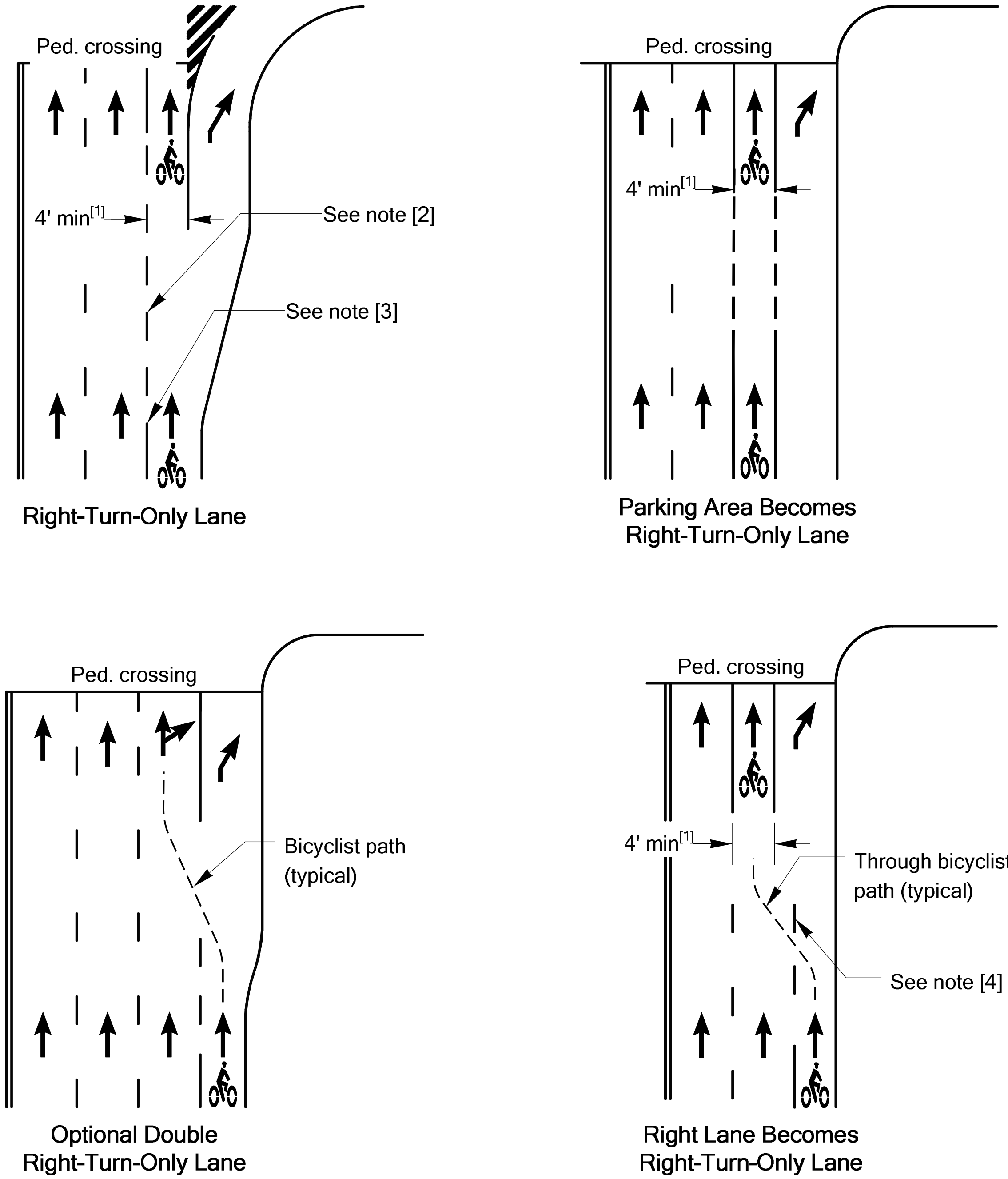
On structures, the bridge railing type and height are part of the structure design. Contact the Headquarters (HQ) Bridge and Structures Office for additional information. (See Chapter 720 for further considerations.)

1520.10 Documentation

For the list of documents required to be preserved in the Design Documentation Package and the Project File, see the Design Documentation Checklist:
www.wsdot.wa.gov/design/projectdev/



Typical Bicycle/Auto Movements at Intersection of Multilane Streets
Exhibit 1520-6



Notes:

[1] If space is available.

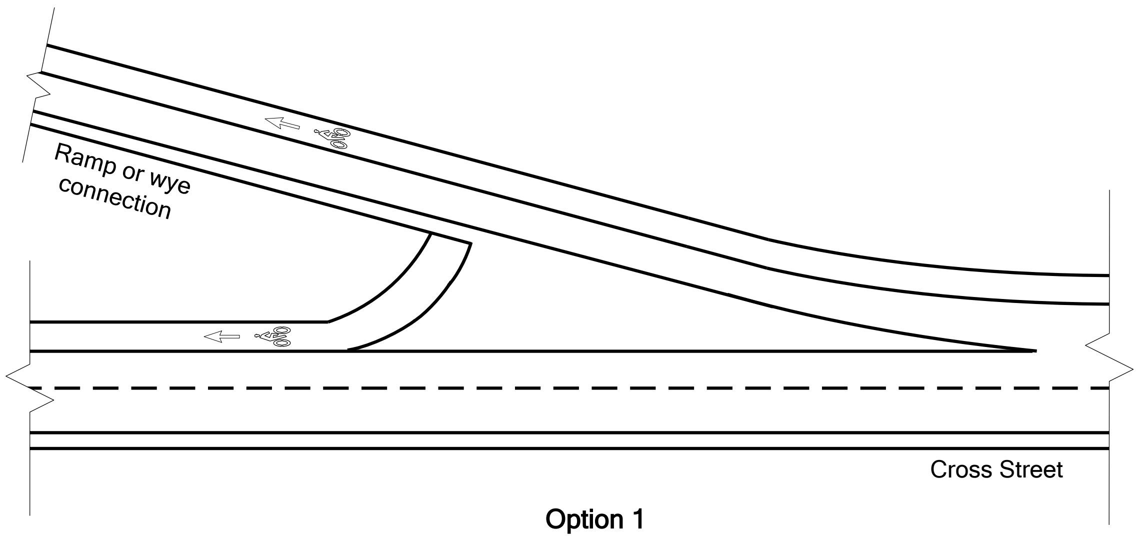
[2] Optional dashed line. Undesirable where a long right-turn-only lane or double turn lanes exist.

[3] When optional dashed line is not used, drop all bike lane delineation at this point.

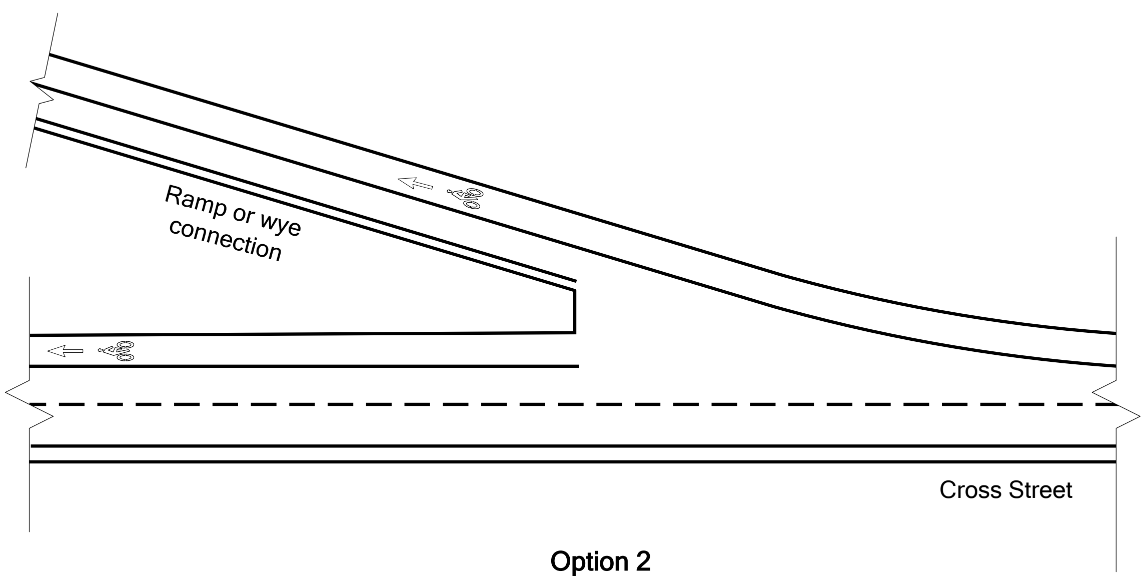
[4] Drop bike lane line where right-turn-only is designated.

Bike Lanes Approaching Motorists' Right-Turn-Only Lanes

Exhibit 1520-7

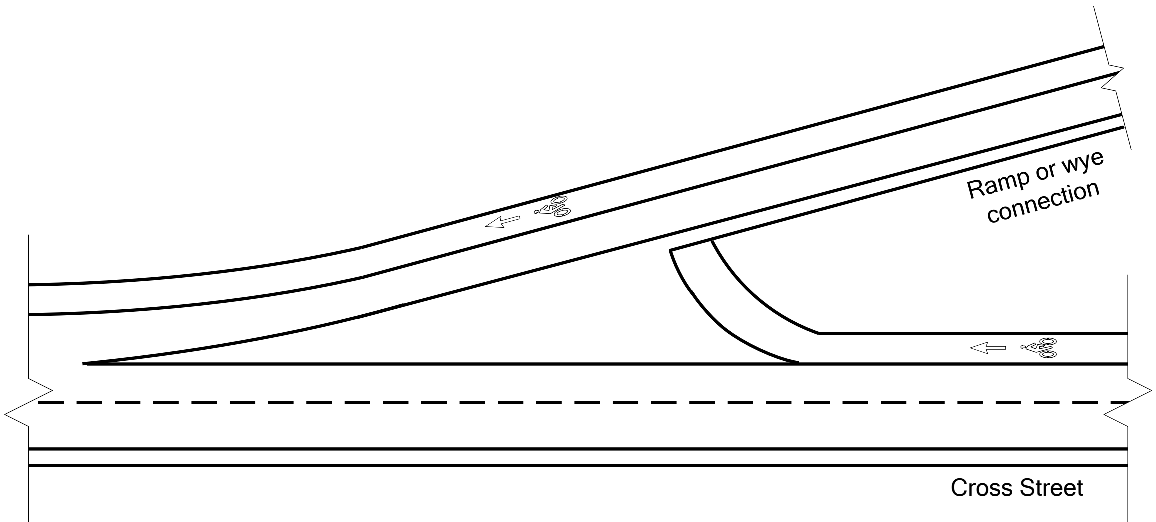


Option 1

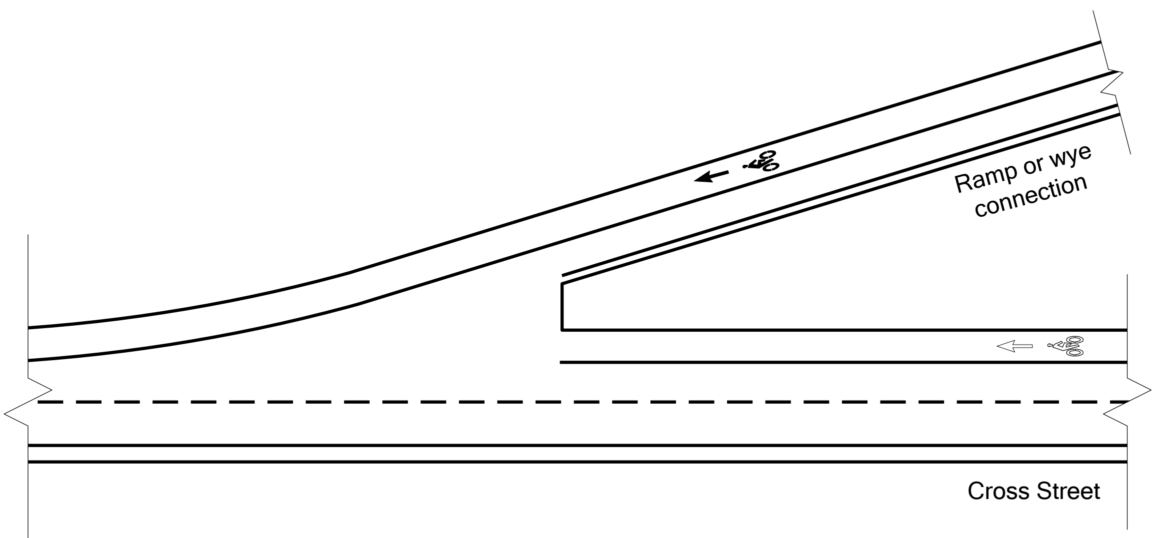


Option 2

Bicycle Crossing of Interchange Ramp
Exhibit 1520-8a

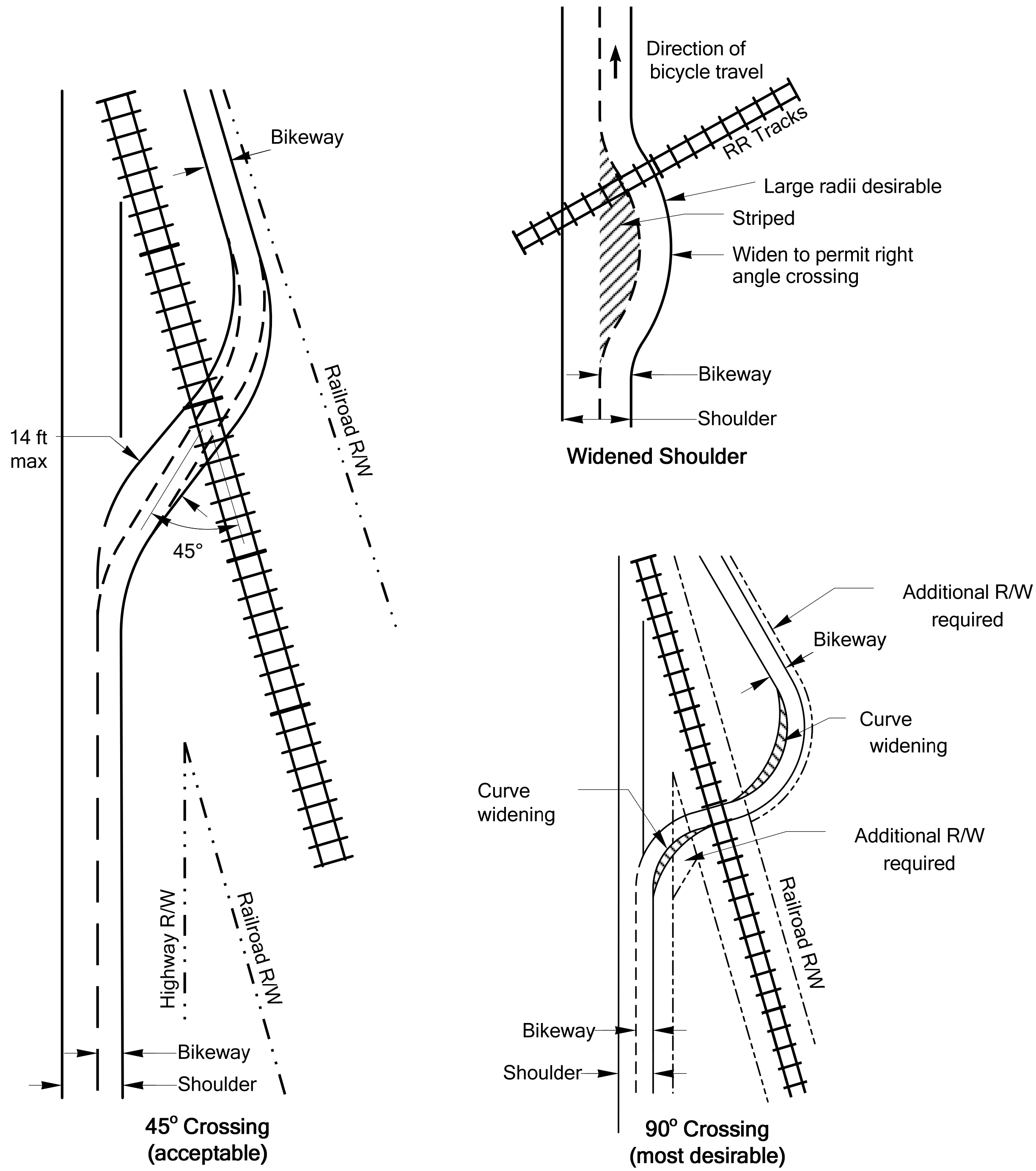


Option 1



Option 2

Bicycle Crossing of Interchange Ramp
Exhibit 1520-8b

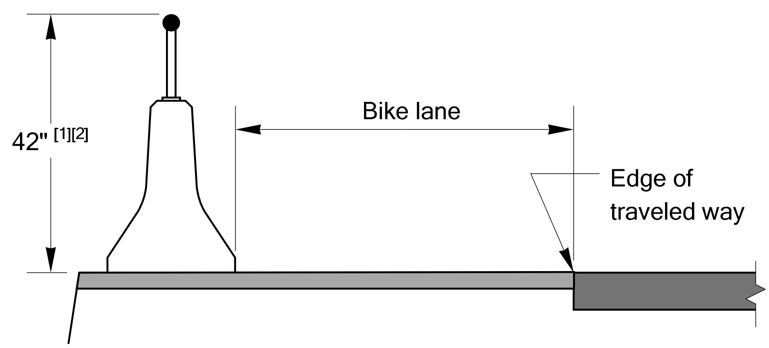


Notes:

Provide additional width to a maximum total width of 14 ft at railroad crossing to allow bicyclists to choose their own crossing routes.

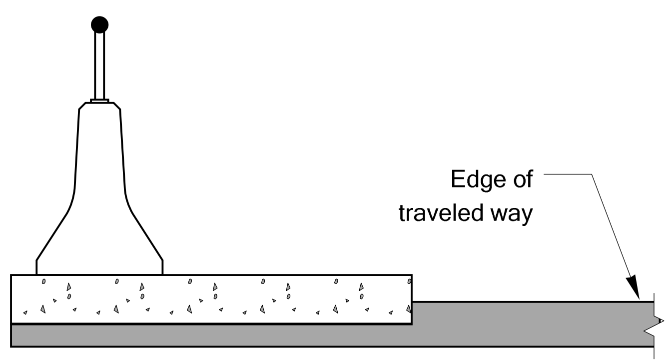
When pedestrians are provided for, design as a shared-use path (see Chapter 1515).

At-Grade Railroad Crossings
Exhibit 1520-9



Bike Lane

Bike lane between edge of traveled way and barrier



Bike Lane With Sidewalk or Curb

Bike lane between edge of traveled way and sidewalk

Notes:

[1] Height does not apply to bridge rail. On structures, the bridge railing type and height are part of the structure design. (Contact the HQ Bridge and Structures Office for additional information.)

[2] Applies to bike lanes. Additional height is not needed for shared-use roadways.

Barrier Adjacent to Bicycle Facilities

Exhibit 1520-10

(b) For ditch sections with foreslopes steeper than 4H:1V and backslopes steeper than 3H:1V, the Design Clear Zone distance is 10 feet horizontal beyond the beginning of the backslope (see Exhibit 1600-4, Case 2, for an example).

(c) For ditch sections with foreslopes steeper than 4H:1V and backslopes 3H:1V or flatter, the Design Clear Zone distance is the distance established using the recovery area formula (see Exhibit 1600-3; also see Exhibit 1600-4, Case 3, for an example).

1600.05 Features to Be Considered for Mitigation

There are three general categories of features to be mitigated: sideslopes, fixed objects, and water. The following sections provide guidance for determining when these obstacles present a significant risk to an errant motorist. In addition, several conditions need special consideration:

- Locations with high collision rate histories.
- Locations with pedestrian and bicycle usage. (See Chapters 1510, Pedestrian Design Considerations, 1515, Shared-Use Paths, and 1520, Roadway Bicycle Facilities.)
- Playgrounds, monuments, and other locations with high social or economic value.
- Redirectional land forms, also referred to as earth berms, were installed to mitigate objects located in depressed medians and at roadsides. They were constructed of materials that provided support for a traversing vehicle. With slopes in the range of 2H:1V to 3H:1V, they were intended to redirect errant vehicles. The use of redirectional land forms has been discontinued as a means for mitigating fixed objects. Where redirectional land forms currently exist as mitigation for a fixed object, ensure the feature they were intended to mitigate is removed, relocated, made crashworthy, or shielded with barrier. Landforms may be used to provide a smooth surface at the base of a rock cut slope.

Use of a traffic barrier for features other than those described below requires justification in the Design Documentation Package.

(1) Side Slopes

(a) **Fill Slopes**

Fill slopes can present a risk to an errant vehicle with the degree of severity dependent upon the slope and height of the fill. Providing fill slopes that are 4H:1V or flatter can mitigate this condition. If flattening the slope is not feasible or cost-effective, the installation of a barrier might be appropriate. Exhibit 1600-5 represents a selection procedure used to determine whether a fill side slope constitutes a condition for which a barrier is a cost-effective mitigation. The curves are based on the severity indexes and represent the points where total costs associated with a traffic barrier are equal to the predicted collision cost associated with selected slope heights without traffic barrier. If the ADT and height of fill intersect on the “Barrier Recommended” side of the embankment slope curve, then provide a barrier if flattening the slope is not feasible or cost-effective.

Do not use Exhibit 1600-5 for slope design. Design guidance for slopes is in Chapters 1130 and 1230. Also, if the exhibit indicates that barrier is not recommended at an existing slope, that result is not justification for a deviation. For example, if the ADT is 4000 and the embankment height is 10 feet, barrier might be cost-effective for a 2H:1V slope, but not for a 2.5H:1V slope. This process only addresses the potential risk of exposure to the slope. Obstacles on the slope can compound the condition. Where barrier is not cost-effective, use the recovery area formula to evaluate fixed objects on critical fill slopes less than 10 feet high.

(b) **Cut Slopes**

A cut slope is usually less of a risk than a traffic barrier. The exception is a rock cut with a rough face that might cause vehicle snagging rather than providing relatively smooth redirection.

Analyze the potential motorist risk and the benefits of treatment of rough rock cuts located within the Design Clear Zone. Conduct an individual investigation for each rock cut or group of rock cuts. A cost-effectiveness analysis that considers the consequences of doing nothing, removal, smoothing of the cut slope, and other viable options to reduce the severity of the condition can be used to determine the appropriate treatment. Some potential options are:

- Graded landform along the base of a rock cut.
- Flexible barrier.
- More rigid barrier.
- Rumble strips.

(2) Fixed Objects

Consider the following objects for mitigation:

- Wooden poles or posts with cross-sectional areas greater than 16 square inches that do not have breakaway features.
- Nonbreakaway steel sign posts.
- Nonbreakaway light standards.
- Trees with a diameter of 4 inches or more, measured at 6 inches above the ground surface.
- Fixed objects extending above the ground surface by more than 4 inches; for example, boulders, concrete bridge rails, signal and electrical cabinets, piers, and retaining walls.
- Existing guardrail that does not conform to current design guidance (see Chapter 1610).
- Drainage items such as culvert and pipe ends.

Mitigate fixed features that exist within the Design Clear Zone when feasible. Although limited in application, there may be situations where removal of an object outside the right of way is appropriate. The possible mitigative measures are listed as follows in order of preference:

- Remove.
- Relocate.
- Reduce impact severity (using a breakaway feature).
- Shield the object by using longitudinal barrier or impact attenuator.

1. **Divided Highways**

Shoulder rumble strips are needed on both the right and left shoulders of rural Interstate highways. Consider them on both shoulders of rural divided highways. Use the Shoulder Rumble Strip Type 1 pattern on divided highways.

Omitting shoulder rumble strips on rural highways is a design exception (DE) under any of the following conditions:

- When another project scheduled within two years of the proposed project will overlay or reconstruct the shoulders or will use the shoulders for detours.
- When a pavement analysis determines that installing shoulder rumble strips will result in inadequate shoulder strength.
- When overall shoulder width will be less than 4 feet wide on the left and 6 feet wide on the right.

2. **Undivided Highways**

Shoulder rumble strip usage on the shoulders of undivided highways demands strategic application because bicycle usage is more prevalent along the shoulders of the undivided highway system. Rumble strips affect the comfort and control of bicycle riders; consequently, their use is to be limited to highway corridors that experience high levels of run-off-the-road collisions. Apply the following criteria in evaluating the appropriateness of rumble strips on the shoulders of undivided highways.

- Use on rural roads only.
- Ensure shoulder pavement is structurally adequate to support milled rumble strips.
- Posted speed is 45 mph or higher.
- Provide for at least 4 feet of usable shoulder between the rumble strip and the outside edge of shoulder. If guardrail or barrier is present, increase the dimension to 5 feet of usable shoulder.
- Preliminary evaluation indicates a run-off-the-road collision experience of approximately 0.6 crashes per mile per year, or approximately 34 crashes per 100 million miles of travel. (These values are intended to provide relative comparison of crash experience and are not to be used as absolute guidance on whether rumble strips are appropriate.)
- Do not place shoulder rumble strips on downhill grades exceeding 4% for more than 500 feet in length along routes where bicyclists are frequently present.
- An engineering analysis indicates a run-off-the-road collision experience considered correctable by shoulder rumble strips.
- Consult the region and Headquarters Bicycle and Pedestrian Coordinators to determine bicycle usage along a route, and involve them in the decision-making process when considering rumble strips along bike touring routes or other routes where bicycle events are regularly held.

The Shoulder Rumble Strip Type 2 or Type 3 pattern is used on highways with minimal bicycle traffic. When bicycle traffic on the shoulder is high, the Shoulder Rumble Strip Type 4 pattern is used.

Shoulder rumble strip installation considered at any other locations must involve the WSDOT Bicycle and Pedestrian Advisory Committee as a partner in the decision-making process.

Consult the following website for guidance on conducting an engineering analysis: www.wsdot.wa.gov/Design/Policy/RoadsideSafety.htm

(c) **Centerline Rumble Strips**

Centerline rumble strips are placed on the centerline of undivided highways to alert drivers that they are entering the opposing lane. They are applied as a countermeasure for crossover collisions. Centerline rumble strips are installed with no differentiation between passing permitted and no passing areas. Refresh pavement markings when removed by centerline rumble strips.

Drivers tend to move to the right to avoid driving on centerline rumble strips. Narrow lane and shoulder widths may lead to dropping a tire off the pavement when drivers have shifted their travel path. Centerline rumble strips are inappropriate when the combined lane and shoulder widths in each direction are less than twelve feet. (See Chapters 1130 and 1140 for guidance on lane and shoulder width.) Consider short sections of roadway that are below this width when they are added for route continuity.

Apply the following criteria when evaluating the appropriateness of centerline rumble strips:

- An engineering analysis indicates a crossover collision history with collisions considered correctable by centerline rumble strips. Review the collision history to determine the frequency of collisions with contributing circumstances such as inattention, apparently fatigued, apparently asleep, over the centerline, or on the wrong side of the road.
- Centerline rumble strips are most appropriate on rural roads, but with special consideration may also be appropriate for urban roads. Some concerns specific to urban areas are noise in densely populated areas, the frequent need to interrupt the rumble strip pattern to accommodate left-turning vehicles, and a reduced effectiveness at lower speeds (35 mph and below).
- Ensure the roadway pavement is structurally adequate to support milled rumble strips. Consult the Region Materials Engineer to verify pavement adequacies.
- Centerline rumble strips are not appropriate where two-way left-turn lanes exist.

(galvanized weathering steel or powder-coated galvanized steel) to minimize the barrier's visual impact (see 1610.05).

Note: In areas where weathering steel will be used and the steel post options cannot be used, the wood post option may be used with justification (Design Decision Memo).

(5) Terminals and Anchors

A guardrail anchor is needed at the end of a run of guardrail to develop tensile strength throughout its length. In addition, when the end of the guardrail is subject to head-on impacts, a crash-tested guardrail terminal is needed (see the *Standard Plans*).

(a) **Buried Terminal (BT)**

A buried terminal is designed to terminate the guardrail by burying the end in a backslope. The BT is the preferred terminal because it eliminates the exposed end of the guardrail.

The BT uses a Type 2 anchor to develop the tensile strength in the guardrail. The backslope needed to install a BT is to be 3H:1V or steeper and at least 4 feet in height above the roadway. The entire BT can be used within the length of need for backslopes of 1H:1V or steeper if the barrier remains at full height in relation to the roadway shoulder to the point where the barrier enters the backslope. For backslopes between 1H:1V and 3H:1V, design the length of need beginning at the point where the W-beam remains at full height in relation to the roadway shoulder—usually beginning at the point where the barrier crosses the ditch line. If the backslope is flatter than 1H:1V, provide a minimum 20-foot-wide by 75-foot-long distance between the beginning length of need point at the terminal end to the mitigated object to be protected.

For new BT installations, use the Buried Terminal Type 2. Note: Previously, another BT option (the Buried Terminal Type 1) was an available choice. For existing situations, it is acceptable to leave this option in service.

1. **Buried Terminal Type 2**

   Flare the guardrail to the foreslope/backslope intersection using a flare rate that meets the criteria in 1610.05(3). Provide a 4H:1V or flatter foreslope into the face of the guardrail and maintain the full guardrail height to the foreslope/backslope intersection in relation to a 10H:1V line extending from edge of shoulder breakpoint. (See the *Standard Plans* for details.)

(b) **Nonflared Terminal**

If a BT terminal cannot be installed as described above, consider a nonflared terminal (see Exhibit 1610-12a). There are currently two acceptable sole source proprietary designs: the ET-31 and the SKT-SP-MGS. These systems use W-beam guardrail with a special end piece that fits over the end of the guardrail. Steel posts are used throughout the length of the terminal. When hit head on, the end piece is forced over the rail and either flattens or bends the rail and then forces it away from the impacting vehicle.

Both the SKT-SP-MGS and the ET-31 terminals include an anchor for developing the tensile strength of the guardrail. The length of need begins at the third post for both terminals.

While these terminals do not need to have an offset at the end, a flare is recommended so that the end piece does not protrude into the shoulder. These terminals may have a 2-foot offset to the first post. Four feet of widening is needed at the end posts to properly anchor the system. For each foot of embankment height, 3 cubic yards of embankment are needed. (See the *Standard Plans* for widening details.)

When the entire barrier run is located farther than 12 feet beyond the shoulder break point and the slopes are greater than 10H:1V and 6H:1V or flatter, additional embankment at the terminal is not needed.

No snowload rail washers are allowed within the limits of these terminals.

When a Beam Guardrail Type 1 nonflared terminal is needed, two sole source proprietary terminals, the ET-PLUS or the Sequential Kinking Terminal (SKT), may be used (see Exhibit 1610-12b). Both of these Type 1 barrier terminals are available in two designs based on the posted speed of the highway. The primary difference in these designs is the length of the terminal. For highways with a posted speed of 45 mph or above, use the 50-foot-long ET PLUS TL3 or the SKT 350 terminal. For lower-speed highways (a posted speed of 40 mph or below), use the 25-foot-long ET PLUS TL2 or SKT-TL2.

The FHWA has granted approval to use the above sole source proprietary terminals without justification.

(c) **Flared Terminal**

WSDOT does not use a flared terminal system for the Type 31 system. However, if a flared terminal is needed for other applications, there are currently two acceptable sole source proprietary designs: the Slotted Rail Terminal (SRT) and the FLared Energy Absorbing Terminal (FLEAT). Both of these designs include an anchor for developing the tensile strength of the guardrail. The length of need begins at the third post for both flared terminals.

1. The SRT uses W-beam guardrail with slots cut into the corrugations and posts throughout the length of the terminal. The end of the SRT is offset from the tangent guardrail run by the use of a parabolic flare. When struck head on, the first two posts are designed to break away, and the parabolic flare gives the rail a natural tendency to buckle, minimizing the possibility of the guardrail end entering the vehicle. The buckling is facilitated by the slots in the rail. The remaining posts provide strength to the system for redirection and deceleration without snagging the vehicle. The SRT has a 4-foot offset of the first post.

   The SRT terminal can be supplied with wood or steel posts. Match the type of SRT posts with those of the longitudinal barrier run to which the terminal will be connected.

2. The FLEAT uses W-beam guardrail with a special end piece that fits over the end of the guardrail and posts. The end of the FLEAT is offset from the tangent guardrail run by the use of a straight flare. When struck head on, the end piece is forced over the rail, bending the rail and forcing it away from the impacting vehicle.

(1) Steel-Backed Timber Guardrail

Steel-backed timber guardrails consist of a timber rail with a steel plate attached to the back to increase its tensile strength. There are several variations of this system that have passed crash tests. The nonproprietary systems use a beam with a rectangular cross section that is supported by either wood or steel posts. A proprietary (patented) system called the Ironwood Guardrail is also available. This system uses a beam with a round cross section and is supported by steel posts with a wood covering to give the appearance of an all-wood system from the roadway. The Ironwood Guardrail can be allowed as an alternative to the nonproprietary system. However, specifying this system exclusively needs approval by an Assistant State Design Engineer of a public interest finding for the use of a sole source proprietary item.

The most desirable method of terminating the steel-backed timber guardrail is to bury the end in a backslope, as described in 1610.06(5). When this type of terminal is not possible, use of the barrier is limited to highways with a posted speed of 45 mph or below. On these lower-speed highways, the barriers can be flared away from the traveled way and terminated in a berm.

For details on these systems, contact the HQ Design Office.

(2) Stone Guardwalls

Stone guardwalls function like rigid concrete barriers but have the appearance of natural stone. These walls can be constructed of stone masonry over a reinforced concrete core wall or of simulated stone concrete. These types of barriers are designed to have a limited projection of the stones to help aid in the redirectional characteristics of the barrier. The most desirable method of terminating this barrier is to bury the end in a backslope, as described in 1610.08(3). When this type of terminal is not possible, use of the barrier is limited to highways with a posted speed of 45 mph or below. On these lower-speed highways, the barrier can be flared away from the traveled way and terminated in a berm outside the Design Clear Zone.

For details on these systems, contact the HQ Design Office.

1610.10 Bridge Traffic Barriers

Bridge traffic barriers redirect errant vehicles and help to keep them from going over the side of the structure. (See the *Bridge Design Manual* for information regarding bridge barrier on new bridges and replacement bridge barrier on existing bridges.)

For new bridge rail installations, use a 2-foot-10-inch-high single slope or a 2-foot-8-inch-high safety shape (F-Shape) bridge barrier. A transition is available to connect the New Jersey shape (Type 2 concrete barrier) and the F-Shape bridge barrier. (See the *Standard Plans* for further details.) Use taller 3-foot-6-inch safety shape or single-slope bridge barriers on Interstate or freeway routes where accident history suggests a need or where roadway geometrics increase the possibility of larger trucks hitting the barrier at a high angle (such as on-ramps for freeway-to-freeway connections with sharp curvature in the alignment).

For further guidance on bridges where high volumes of pedestrian traffic are anticipated, see Chapters 1510, 1515, and 1520.

Approach barriers, transitions, and connections are usually needed on all four corners of bridges carrying two-way traffic and on both corners of the approach end for one-way traffic. (See 1610.06(6) for guidance on transitions.)

If the bridge barrier system does not meet the criteria for strength and geometrics, modifications to improve its redirectional characteristics and its strength may be needed. The modifications can be made using one of the retrofit methods described below.

(1) Concrete Safety Shape

Retrofitting with a new concrete bridge barrier is costly and needs to have justification when no widening is proposed. Consult the HQ Bridge and Structures Office for design details and to determine whether the existing bridge deck and other superstructure elements are of sufficient strength to accommodate this bridge barrier system.

(2) Thrie Beam Retrofit

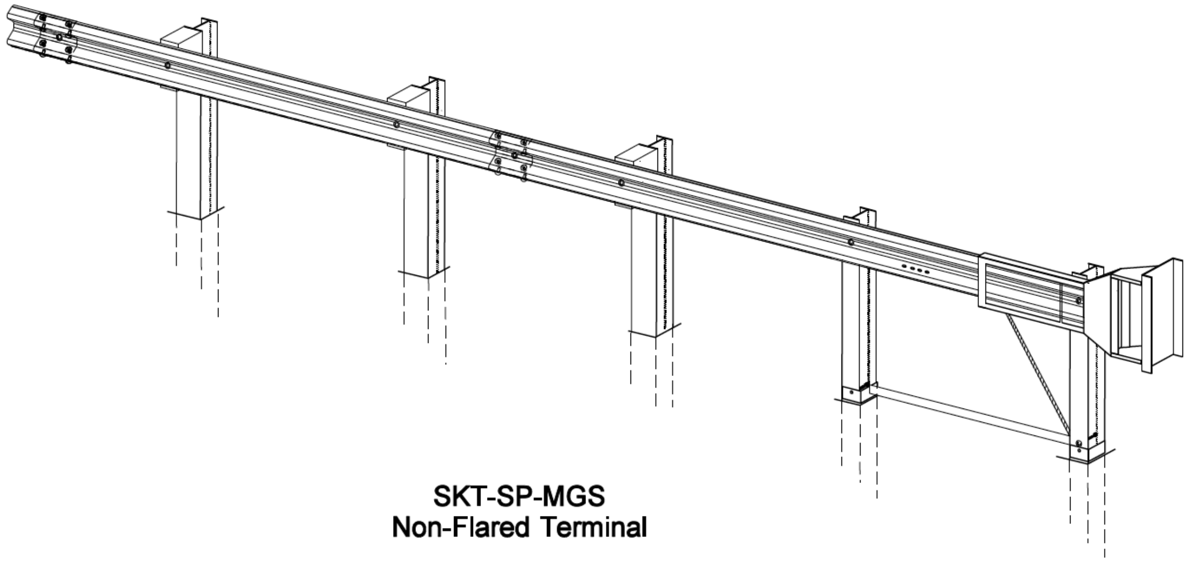
Retrofitting with thrie beam is an economical way to improve the strength and redirectional performance of bridge barriers. The thrie beam can be mounted to steel posts or the existing bridge barrier, depending on the structural adequacy of the bridge deck, the existing bridge barrier type, the width of curb (if any), and the curb-to-curb roadway width carried across the structure.

The HQ Bridge and Structures Office is responsible for the design of thrie beam bridge barrier. Exhibit 1610-14 shows typical retrofit criteria. Contact the HQ Bridge and Structures Office for assistance with thrie beam retrofit design.

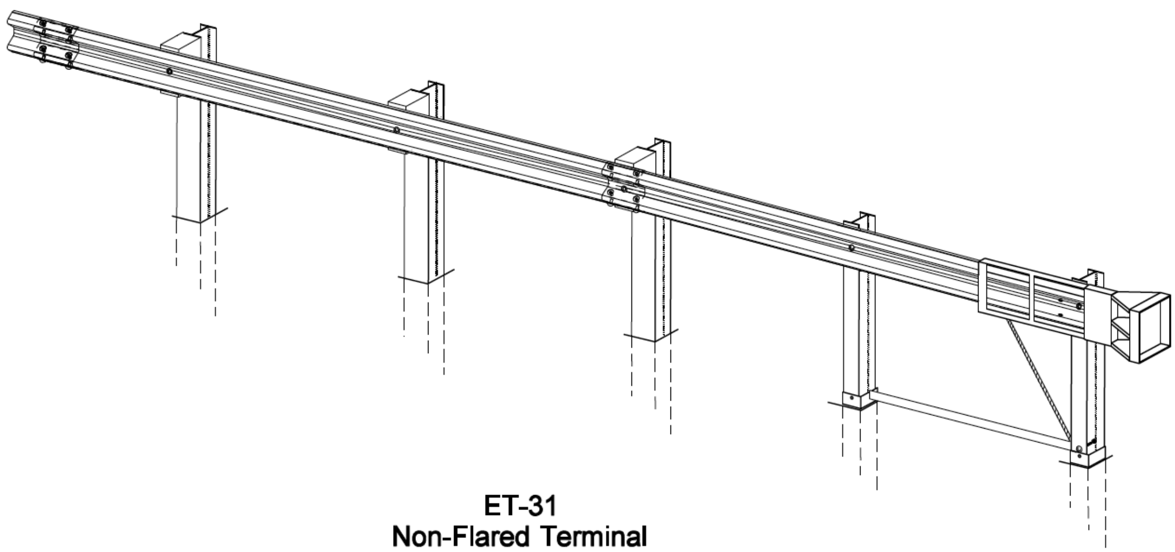
Consider the Service Level 1 (SL-1) system on bridges with wooden decks and for bridges with concrete decks that do not have the needed strength to accommodate the thrie beam system. Contact the HQ Bridge and Structures Office for information needed for the design of the SL-1 system.

A sidewalk reduction of up to 6 inches as a result of a thrie beam retrofit can be documented as a design exception.

The funding source for retrofit of existing bridge rail is dependent on the length of the structure. Bridge rail retrofit, for bridges less than 250 feet in length, or a total bridge rail length of 500 feet, is funded by the project (Preservation or Improvement). For longer bridges, the retrofit can be funded by the I-2 subprogram. Contact the HQ Program Development Office to determine whether funding is available.

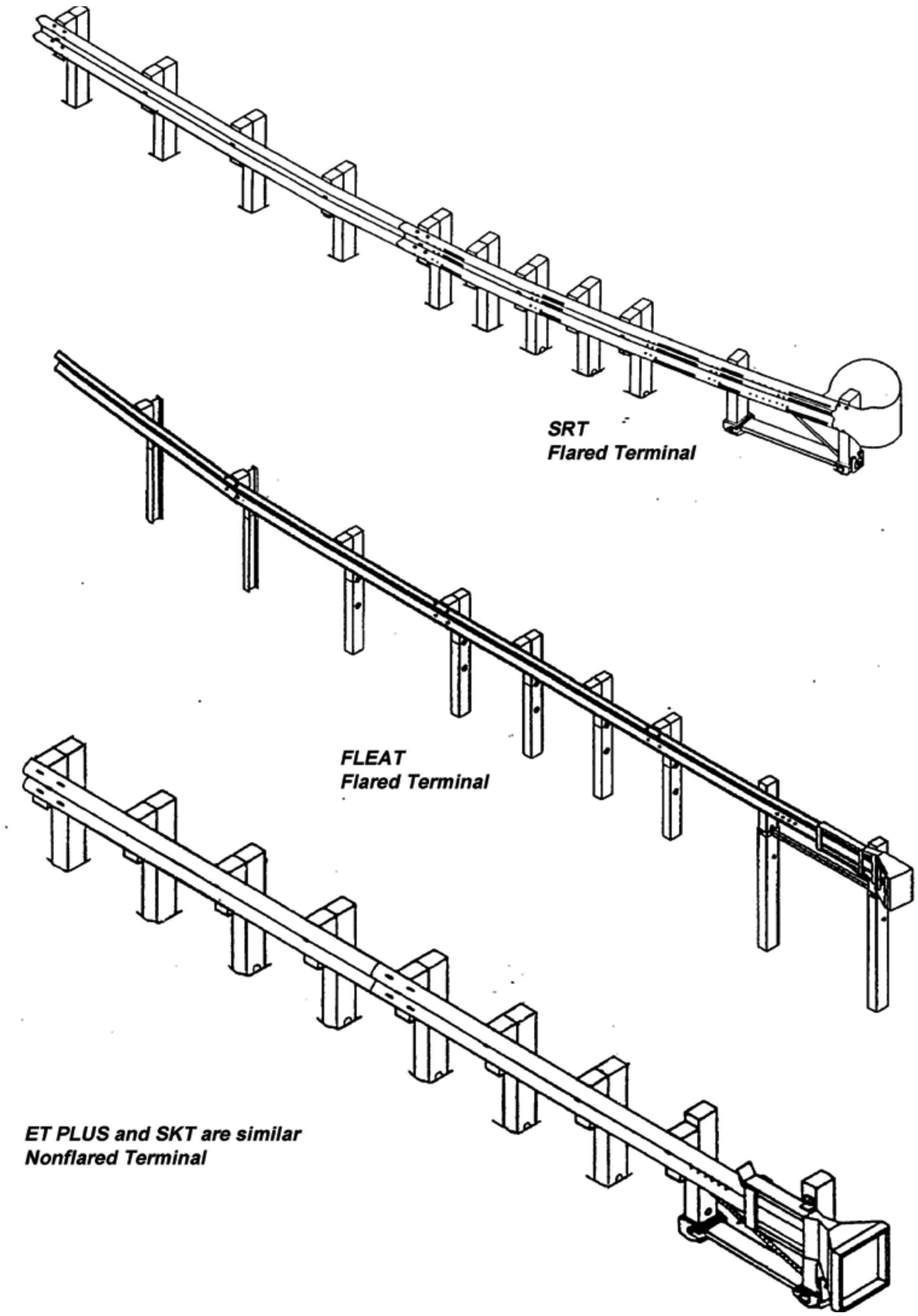


SKT-SP-MGS
Non-Flared Terminal



ET-31
Non-Flared Terminal

Beam Guardrail Terminals
Exhibit 1610-12a



Beam Guardrail Terminals
Exhibit 1610-12b